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## AUTOMOTIVE

### 2005 POPULAR MECHANICS RACING CALENDAR

Check back often for the latest points standings for all racing series throughout the season. Just go to [www.popularmechanics.com/links/racing](http://www.popularmechanics.com/links/racing).



## TECHNOLOGY

### TALKING PICTURES

Toys? No longer. With sharper resolution and better design, camera phones are now seriously useful. Go to [www.popularmechanics.com/links/cameras](http://www.popularmechanics.com/links/cameras) for the latest in camera phones.



## HOME JOURNAL

### HOW TO SAVE ON HOME AND ENERGY BILLS

Here are some tips from Energy Star, a public awareness program developed by the Environmental Protection Agency and the Department of Energy. Go to [www.popularmechanics.com/links/energy](http://www.popularmechanics.com/links/energy).



## OUTDOORS

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# Cutting Through The Fog Of War

**Knowledge is power, and never more so than in warfare.** This month's cover story ("Nowhere To Hide," page 54) is a remarkable look at an aspect of the Iraq war that has garnered surprisingly little attention in the mainstream press: the growing use of small, low-cost Unmanned Aerial Vehicles (UAVs) to provide real-time intelligence to our forces.

In the weeks leading up to the operation to reclaim the insurgent-held Iraqi city of Fallujah, the American press focused on the inherent dangers of urban warfare. Many feared that the coalition forces would be at a disadvantage in the narrow streets and chaotic warrens of that ancient city. And it's true that the battle for Fallujah offered enormous challenges to the U.S. soldiers and Marines who did the bulk of the fighting. But our forces had a technological advantage that more than leveled the playing field: As the coalition retook the city block

by block, small, remote-control Pioneer surveillance aircraft flew lazy circles overhead, streaming back intelligence to troops on the ground.

When the offensive began, author Bing West, a former Marine himself, shadowed a Marine squadron known as the Watchdogs as they tended their small flock of 14-ft.-long Pioneers, and coordinated the steady flow of information. With their eyes in the sky, the Marines could study the insurgents' tactics and identify their safe houses. And when the time came to strike, they could help direct an impressive array of shooters with pinpoint precision—artillery, Harrier jets, AC-130 Spectre gunships, even other aerial drones equipped with missiles.

Throughout history, military technology has become ever more lethal. But as West's article makes clear, our military's growing use of UAVs reflects a largely unsung revolution in military thinking. Instead of using

our huge technological advantage to spread greater devastation, our forces increasingly rely on high-tech surveillance and targeting to limit the need for massive firepower. By locating the enemy sooner and from a greater distance, our forces can minimize civilian casualties even as they fight more effectively.

West is the author of three books on military affairs, including the Vietnam memoir *The Village* and the novel *The Pepperdogs*. His fourth, *No True Glory: Fallujah And The Struggle In Iraq—A Frontline Account*, will be published in May by Bantam Books.

Also in this issue, West Coast editor Ben Stewart and the rest of PM's automotive team tackle the great mileage debate. Hybrid vehicles have gotten all the press lately for their high-efficiency pairing of a gasoline engine with electric propulsion. But diesel engines—one of the original automotive technologies—have always been efficient. And now diesels are back in a big way, as carmakers offer a number of peppy but frugal designs. So what's a mileage-conscious consumer to do? To find out, our automotive editors spent five days comparing three hot-selling hybrids with three comparable diesel models. The great faceoff begins on page 60.

*James Meigs*  
James Meigs



**OUR MAN IN IRAQ:** Former Marine Bing West files a front-line report from Fallujah on a Marine squadron that operates remote-control spy planes used to send live video feeds to ground forces, tracking insurgents and safeguarding civilians.



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Wendy Logroff  
Business Associate

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Your written letters are always welcome. If we think your letter would be interesting to other readers, we might even print it in our Letters column (unless you request that it not be printed). Send your letter to one of our editors, who are listed by department on the masthead on the left. You can send it in any of the following ways:

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Until tomorrow.

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# Wish List

As a longtime motorcyclist and subscriber, I was really irritated that you picked a Jesse James custom chopper as the No. 1 item on your "Wish List" (Dec. 2004). Choppers are "home" made, not "custom" made. They are also uncomfortable and handle more like barges than true motorcycles. Worse, many of the people who buy them also buy into the lunacy that it's only cool to ride if you're wearing a rag for a helmet, and a T-shirt and jeans, instead of safe riding gear.

JOHN WESTCOTT  
San Antonio, TX

## LINUX

Thank you for reviewing Linux ("Logging Into Linux," Dec. 2004). I am elated that someone has finally pointed out how user-friendly it is.

JIM JENETS  
Via Internet

I have been using Linux (along with Windows 2000 Server) for a class I am taking. Linux has crashed several times, but I have yet to crash in Windows 2000, and Windows has been far easier to set up. Once this class is over, I will remove Linux and pay the big bucks just to never have to deal with that convoluted mess again.

PATRICK HOLECEK  
Via Internet

## RADIO RADIO

I recently listened to a satellite radio like the one Rebecca Day tested

("Sat Radio," Dec. 2004). It was neat, and I loved the variety. But, satellite radio will take a back seat to the local stations until it can provide local events and news.

DAVID KIRKSEY  
Gulfport, MS

## COURAGE AFTER FIRE

When I first saw the picture of Army Spc. Kevin Pannell on the Editor's Notes page, it looked like an ordinary picture of him with his son, but then I saw he had no legs. In your article ("Courage After Fire," Dec. 2004), it is clear that he has an impressive inner strength and will to live. It was inspiring to read about his desire to pursue a career in occupational therapy and to work with amputees. Army Spc. Kevin Pannell is a fine example of someone using his experience to help others.

JAY HOWARD  
Brooklyn, NY

I would like to say "thank you" to Kevin Pannell.

F.M. FOLEY  
Via Internet

## IT IS ROCKET SCIENCE

Your article ("The X Factors," Dec. 2004) has what I assume to be a typo. Reaction thrusters control "attitude," not "altitude" (unless rocket scientists have come up with larger reaction thrusters than were around when I worked in the rocket industry).

MILT WOODHAM  
Colorado Springs, CO

## CHECKING IN



PM contributing editor Leslie Sabbagh's article about Army Spc. Kevin Pannell and his arduous rehabilitation from his wounds in Iraq generated a strong response from readers. Pannell, who is now regularly walking on his two prosthetic legs, recently sent us this update, along with the photo (above) of him with his new pickup truck:

*I would like to personally express my compliments on a job well done with the December PM article on me. Leslie's piece was outstanding in my opinion and I believe that PM is lucky to have her as a contributor. I felt that I could trust her and certainly had to, as this was my first major media coverage. I am more than pleased with the way that it turned out. Please feel free to print my e-mail address, brokendownyoung@yahoo.com, in the magazine. I love to get feedback from the readers and will answer anyone who writes.*

*Thank you again,  
Kevin "Stumpy" Pannell*

Readers who would like to help out other wounded U.S. forces now going through rehabilitation are encouraged to contribute to the Wounded Warrior Project ([www.woundedwarriorproject.org](http://www.woundedwarriorproject.org)), a nonprofit group that offers supplies, training and support to veterans working to rebuild their lives.

**Correction:** A number of readers wrote to note that Ford does not offer an F-250 Super Duty in a dualie configuration. The truck that Ford delivered to us for our story "King Of The Load" (Dec. 2004) was a factory prototype, and Ford decided not to offer that configuration under the F-250 badge. However, Ford offers the 350 pickup in a dualie version. In "Courage After Fire," (Dec. 2004) we misspelled the name of the Rehabilitation Institute of Chicago.

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Best-selling wagon claim based on R.L. Polk & Co. new vehicle retail registration statistics for 1999, 2000 and 2001 (excludes luxury segment). The ABC's of Safety: Air Bags. Buckle up. Children in backseat.



# Fitness Test

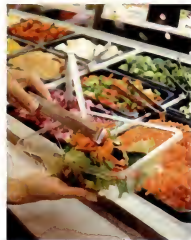
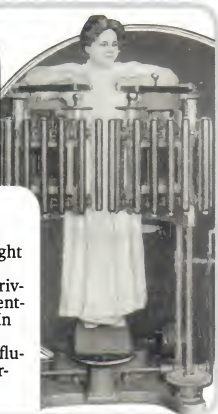
After decades of dieting, it's hard to tell whether the machines are working for us or against us.

# 90

**Years Ago** (JANUARY 1915)

## THE ELASTIC WAISTBAND?

In the good old days, losing weight meant undergoing massage by giant rolling pins instead of depriving oneself of junk food like recently introduced Hershey's Kisses. In this case, two form-fitting roller belts were said to reduce "superfluous flesh" without sacrifice, exertion (or scientific explanation).



# 75

**Years Ago** (JANUARY 1930)

## HIGH POINT IN GLUTTONY

Paving the way for competitive eating and the obesity epidemic, the first "pay-as-you-enter restaurants" opened their doors. Unlike today's stationary spreads (shown here), these buffets involved conveyor belts, which rolled out the entire menu every 2 minutes, providing at least some exercise as diners chased down seconds—and thirds.

# 25

**Years Ago**  
(OCTOBER 1980)



## DIY SPINNING

Before Jazzercise and Jane Fonda, the '80s exercise craze started out with projects such as this DIY exercise bike. Using an aluminum chair frame for support and an old bath towel to wedge between the brake caliper and wheel rim for resistance, a regular bicycle became stationary. You could pop the bike out to use on the road (unlike its home gym successors, which inevitably ended up at the neighborhood yard sale).

# 45

**Years Ago**  
(MARCH 1960)



## REVENGE OF THE MACHINES

Overeaters Anonymous was founded the year that PM reported on the first membership gym chains. We noted that they "look like factories, except that the people ... work the machines instead of letting the machines work them."

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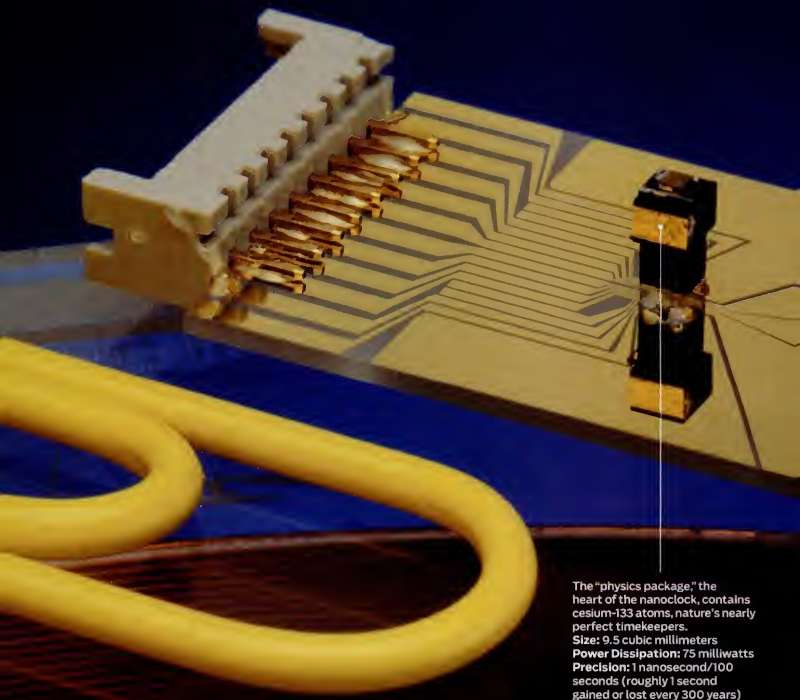


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# TECHWATCH

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seconds (roughly 1 second gained or lost every 300 years)

## Tiny Timer

**The world's most accurate clocks can now fit on a microchip, thanks to micromachining techniques borrowed from the semiconductor industry.**

The smallest atomic clocks currently in use are the size of a deck of cards, and can be found on GPS satellites and in cellphone towers. The microfabricated atomic clock mounted to this baseplate is roughly the size and weight of a grain of rice, and could greatly enhance the accuracy of GPS receivers in everything from handheld navigators to cellphones, says John Kitching of the National Institute of Standards and Technology in Boulder, Colo., where the new clock was built.

Kitching sees the technology as being two to three years from the consumer market, with an estimated cost of \$100—10 times less than the current state of the art.

—Alex Hutchinson







2/05



## Highest Flier In Vegas

Which is the more dangerous place to be on Feb. 21—on the inaugural spin of *Insanity: The Ride* or underneath it? This new Las Vegas attraction will dangle its queasy passengers 64 ft. over the edge of the tower of the Stratosphere Casino Hotel—that's 906 ft. above the ground. The mechanized arm will spin 10 riders at a time in an inverted centrifuge at 40 mph until all the money has shaken free from their pockets or until they throw up every last bite they took from the all-you-can-eat buffet.

**Groundhog Day** ... comes from an ancient European superstition that if any hibernating animal casts a shadow on Feb. 2, winter will last another six weeks ... in 118 appearances by seemingly immortal woodchuck Punxsutawney Phil, there have been 94 calls for more winter ... according to Internet bookie Kyle Fratini, odds are 1-7 Phil will see his shadow, 4-1 that he won't ... the coldest recorded temperature for the event at Phil's home at Gobbler's Knob was minus 25° in 1961 ... on that day, he saw his shadow and quickly went back to bed.

## Best Use Of Learner's Permit

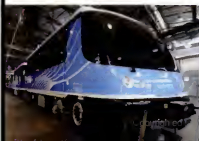
The Racer's Group is fielding the youngest driver lineup ever in the Rolex 24 at Daytona (Feb. 5-6). In this grueling 24-hour endurance race, teams can log over 2000 miles at speeds up to 190 mph. All three racers are 16 years old, and will take turns driving a Porsche 911 GT3 (No. 16, of course).

## Most Overlooked Birthday

Charles Darwin was born Feb. 12, 1809, just like Lincoln. They don't give three-day weekends to evolutionists, but Darwin Day is an unofficial holiday celebrated by some of the 35 percent of Americans who believe in evolution. (The other two-thirds reject the idea or are undecided.)

## Slowest Rapid Transit

We were all excited to hear about the world's largest high-speed airport train—the \$895 million Skylink that is coming to Dallas/Fort Worth Airport. Then we found out just what “high speed” meant. Skylink will glide along a 4.8-mile track at the dizzying velocity of 35 mph—about 40 mph slower than the top speed of a Vespa.



# Every king deserves a Crown.



**Congratulations to Kurt Busch, the 2004 Nextel Cup champion.  
Look for Kurt next year in the #97 Crown Royal car as he races for another crown.**



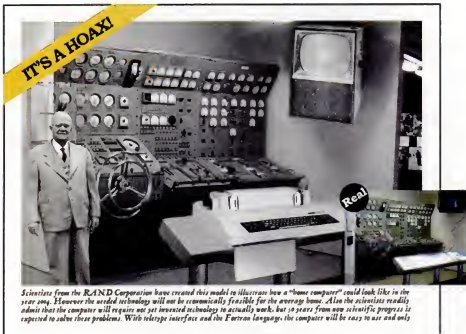
***Be a champion. Drink responsibly.***

*For more information visit [www.crownroyal.com/racing](http://www.crownroyal.com/racing)*

## Don't Blame Us

Last November, requests started rolling in for copies of a 1954 *POPULAR MECHANICS* article that supposedly featured a photo of a "home computer from the year 2004" that had been circulating on the Internet. PM's archival department took a close look at the photo (below) and everyone agreed that something wasn't quite right. More research revealed, much to our relief, that this was one prediction we did not make.

We tracked down Troels Eklund Andersen, a Danish software company employee, who originally entered the image in an online photo manipulation contest. He took a photo of a mock submarine control room (inset) and added a 1950s-era Crosley Ridgewood TV, a 1970s Teletype, a hardware store owner from Ohio and a pseudoscientific caption. "I wasn't intending to create a believable fake," he says. As for the guy who attached PM's name to it, our agents are still searching for him. Come on, now, we know you're out there.



*Scientists from the RAND Corporation have created this model to illustrate how a "home computer" could look like in the year 2004. However, the needed technology will not be economically feasible for the average home. Also, the scientists readily admit that the computer will require yet untested technology to actually work, but it starts from one scientific progress is expected to solve these problems. With tele-type interfaces and the Farnum language, the computer will be easy to use and only*

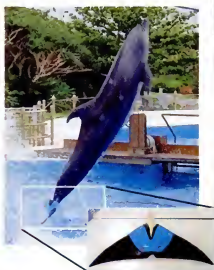
## "Take That, Human Intruder!"

**Intruders at Japanese seaports** and factories may soon discover that the long arm of the law has wheels and spews smoke. The diminutive cybersheriff, named Robot X, comes from Secom, Japan's leading security company. When Robot X hits production it is expected to cost around 300,000 yen (about \$2900) per month—less than the cost of an old-fashioned human guard.

Most of the time, Robot X works on the same principle as the Roomba vacuum cleaner: Give it a predetermined route to cover and it will rush off without even stopping for tea. Robot X uses laser sensors and cameras to survey its surroundings. If it senses trouble, it contacts a human who takes over and remotely guides Robot X in pursuit. Chugging along at a top speed of 6.2 mph and armed with a benign arsenal of floodlights and a smokescreen, Robot X is equipped with all the tools necessary to incapacitate criminals with laughter.



## TICKER TECH



### Frankenflipper

The aquatic world was greatly saddened when Fuji, a dolphin at a Japanese aquarium, lost 75 percent of her tail due to necrosis. Aquarium officials turned to tire manufacturer Bridgestone, which developed a nearly \$100,000, 4.4-pound, 20-in.-wide artificial fin, which is held together with bolts. The faux tail may sound uncomfortable, but all reports say that Fuji has taken to it nicely and is jumping for joy.

### Fueling The Format War

As we reported in our December story "High-Definition Smack-Down," the battle for dominance among the next generation of high-def discs has until now favored Sony-, Columbia- and MGM-supported Blu-ray discs. But recently Paramount, Universal and Warner Bros. sided with rival technology HD-DVD. How can we possibly choose between Blu-ray "Christmas With The Kranks" and "Miss Congeniality 2" on HD-DVD?

### Breathe Easier

Severe halitosis (aka bad breath) has a new method of treatment. Israeli scientists have been experimenting with a 15-minute laser surgery that zaps the mouth's breeding ground for gas-producing bacteria and vaporizes infected tissue.

TECH WATCH CONTRIBUTORS:  
Aaron Dalton, Glenn Derene,  
James Ross, Tracy Saelingier.



TM

***Nicorette introduces a stop smoking gum  
that actually tastes like gum.***

New Nicorette® fresh mint gum. It tastes better, which means you might actually use it. Which means, this time it could help you quit.



Use as directed. Start with 1 piece every 1 to 2 hours, and follow dosing schedule. Do not exceed 24 pieces a day. Support program improves chances of success. Individual results may vary. For more information, please visit [www.nicorette.com](http://www.nicorette.com). © 2004 GlaxoSmithKline Consumer Healthcare, L.P.





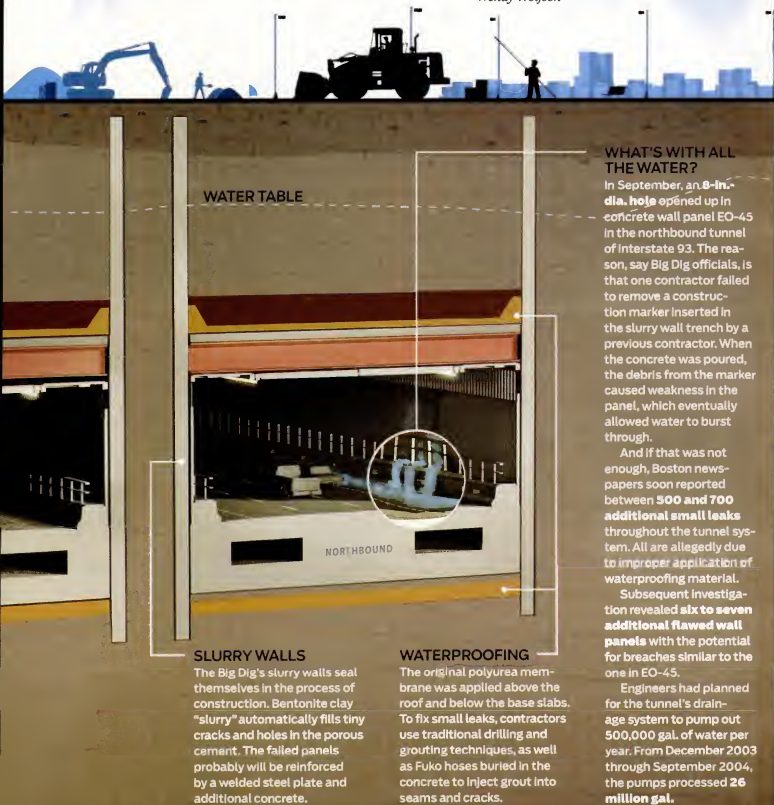
## The Big Leak

Boston's Big Dig is the most expensive highway project in U.S. history. Riddled with cost and time overruns, it has been widely considered a nexus of mismanagement and messy politics. Beantowners have spent the last 14 years negotiating byzantine redirections of traffic with mounting frustration, despite assurances that one day the city will be rewarded with an engineering marvel. Now, the crucial Central Artery/Tunnel is open to traffic—and it leaks.

—Wendy Wolfson

### BALLOONING BUDGET

1985 estimate = \$2.6 billion  
1991 estimate = \$5.8 billion  
2000 estimate = \$13.5 billion  
2004 estimate = \$14.6 billion



WATER TABLE

### WHAT'S WITH ALL THE WATER?

In September, an 8-in.-dia. hole opened up in concrete wall panel EO-45 in the northbound tunnel of Interstate 93. The reason, say Big Dig officials, is that one contractor failed to remove a construction marker inserted in the slurry wall trench by a previous contractor. When the concrete was poured, the debris from the marker caused weakness in the panel, which eventually allowed water to burst through.

And if that was not enough, Boston newspapers soon reported between **500 and 700 additional small leaks** throughout the tunnel system. All are allegedly due to improper application of waterproofing material.

Subsequent investigation revealed **six to seven additional flawed wall panels** with the potential for breaches similar to the one in EO-45.

Engineers had planned for the tunnel's drainage system to pump out 500,000 gal. of water per year. From December 2003 through September 2004, the pumps processed **26 million gal.**

### SLURRY WALLS

The Big Dig's slurry walls seal themselves in the process of construction. Bentonite clay "slurry" automatically fills tiny cracks and holes in the porous cement. The failed panels probably will be reinforced by a welded steel plate and additional concrete.

### WATERPROOFING

The original polyurea membrane was applied above the roof and below the base slabs. To fix small leaks, contractors use traditional drilling and grouting techniques, as well as Fuko hoses buried in the concrete to inject grout into seams and cracks.





Another satisfied body part,  
brought to you by ThermaCare.

It's the news your knees have been waiting for: ThermaCare is now available in a knee wrap. Eight hours of continual heat relief for reduced knee stiffness. No more cords, no more smelly creams, no more unhappy knees.

**Wrap Yourself in Relief.**





# The Future Of Cable

BY LESLIE ELLIS

**Bit by bit, television is going digital,** and the cable companies want you to go digital, too. They want to send you more programming, more Internet, more HDTV—more, more, more. But most cable subscribers don't have digital sets and have no intention of buying any expensive, high-def mumbo jumbotrons anytime soon. And until they do, cable companies can't stop broadcasting analog TV.

If it carried nothing else, the coaxial cable running into your house could deliver about 125 analog channels. That same wire, however, can carry

twice as many digital high-definition channels, or six times as many standard-definition digital channels. But not everything can fit down the pipe at the same time. So the providers are working on a few bandwidth-bending tricks to try and pump as much content through the cables as they can.

## THE SIMULCAST

Many TV watchers are already hooked up to a service that's being sold as "digital cable," but the name is slightly misleading. Today's digital cable is actually an amalgam of analog and

digital signals—the 70 to 80 analog channels (the same ones that every other subscriber gets by just plugging the co-ax cable into the back of their TV) take up 75 percent of cable bandwidth, while hundreds of extra digital channels as well as broadband Internet and digital phone service exist in the remaining 25 percent. In the near term, cable has to be all things to all people, so many providers are quietly evolving toward a complete "digital simulcast" wherein all of the video channels that are currently analog will also be sent as digital. Charter Communications started the trend last July for its customers in Long Beach, Calif. Cable monolith Comcast is looking at rolling out a digital simulcast on all of its systems this

*(Please turn to page 26)*

ILLUSTRATION BY AARON GOODMAN

# The Goods

Great products and promotional offers from PM advertisers

## Edge Advanced Gel

New Edge® Advanced™ shave gel will give you the most comfortable, refreshing shave you can get. It's Edge® gel's best protection ever from nicks, cuts and irritation. Plus, Edge® Advanced™ gel's unique refreshing ingredients give you a conditioning sensation you can actually feel for the most refreshing shave ever. New Edge® Advanced™ gel. Refresh your shave.™ [www.insideedge.com](http://www.insideedge.com)



## Gillette Sensor 3 Disposable

This is no ordinary disposable razor. It's Sensor 3 from Gillette. It's the only disposable with three spring-mounted Sensor blades to adjust to every curve of your face. Plus it's got a non-slip handle for better control. And an Aloe strip for extra lubrication. In tests against the leading triple-blade disposable, more men chose Gillette Sensor 3. It's the best disposable you ever threw away.

## Hitachi's C12LCH 12" Compound Miter Saw with LCD display and Laser Marker

Hitachi's new 12" compound miter saw offers the latest in power tool technology. With its revolutionary, digital, Liquid Crystal Display, the C12LCH takes the guess work out of miter and bevel readings. Now, even when working in dimly lit areas, this back-lit digital display gives you clear and accurate readings to save time and eliminate mistakes. Other features include a powerful 15 Amp motor, vibration reducing horizontal handle, and Hitachi's exclusive laser marker system. The C12LCH was recently named one of the Top Ten Most Innovative Tools of 2005 by Workbench magazine. (800) 829-4752 [www.hitachipowertools.com](http://www.hitachipowertools.com)

# HITACHI



## Ryobi® AIRgrip™ offers Revolutionary Technology

Ryobi's new AIRgrip laser level is a first of its kind product that uses vacuum technology to affix itself to walls without marring finished surfaces. Perfect for painters, carpenters, homeowners or any do-it-yourselfer, it is easy to use with its 360-degree rotating head offering multiple capabilities for both vertical and horizontal applications. AIRgrip is ideal for installing a chair rail, hanging pictures and lining up flooring.

For more information visit [www.ryobitools.com](http://www.ryobitools.com) or call 1-800-525-2579.



year. As consumers adopt full digital packages, the cable providers can free up bandwidth for lots more HDTV and interactive services.

#### MORE ON DEMAND

One of the most important of those interactive services is video on demand (VOD). Cable's two-way systems allow viewers to call up television content stored on remote servers—kind of like a massive TiVo that you can tap into from home. VOD is evolving from its origins as a pay-per-view-when-ever-you-want-to service offering a couple of movies to a more general television bank from which viewers can call up their favorite shows at any time. Most cable operators are vastly expanding the capacity of their video server banks. What was a thousand hours of storage (mostly movies) in 2004, will swell tenfold over the next few years—Comcast, for example, says its servers are being outfitted to hold up to 10,000 hours

of video. What's more, because cable companies want to entice customers to switch their equipment to digital, much of that content will be free.

#### VIRTUAL CHANNELS

As more television signals are broadcast digitally, VOD technology can be pushed to the next level. Hundreds of digital channels may seem impressive, but a fully digitized cable system has the potential to be far more flexible than that. Since video-on-demand content already can be stored on remote servers, lightly viewed fare could be set up on a switched channel to broadcast upon request. (Say, for instance, that you want to watch the Home Macramé Channel in Dutch. Then you would call up the entire channel much like you would a VOD program or movie now.) Switched broadcasts could free up additional bandwidth and the number of potential channels would be limited only

by server storage space. So far, two cable firms have tested this technology: Time Warner Cable in its Austin, Texas, system, and Cox Communications in Tyler, Texas.

There is one snag: None of this two-way functionality is built into TVs yet. To access features like switched broadcasts, viewers must rely on sophisticated (and often expensive) set-top tuner boxes. Until more sophisticated TVs or cheaper set-top boxes come out, cable operators will move cautiously, nudging the transition forward by using advanced features to get more people on the digital bandwagon. Regardless, there is a rich buffet coming in the near future. That means more to watch without being locked into linear broadcast schedules. That also means that the days are numbered for old-fashioned plug-and-play analog sets. Before long, "cable-ready" may well have a different meaning. **FM**

## THE DIFFERENCE BETWEEN "HERE'S MY NUMBER" AND "HERE'S MY REAL NUMBER."



Look Sharp.™

## The Higher Pliers

You wouldn't think there'd be much room for innovation in hand tools. But you'd be wrong. Sure, hammers, screwdrivers and saws have been around forever—and the designs have pretty much been perfected. Yet, the Knipex Plier Wrench (\$60 to \$84) proves that there's still room for elegant, simple engineering that has nothing to do with silicon, electric motors or carbon fiber. The German manufacturer has created something uniquely useful with its self-locking, cam-actuated tool that can seize upon a nut firmly and yet release it with ease, over and over again. The patented system is one-hand adjustable, and the smooth jaws won't do damage to chrome-plated or soft fixtures. It is strong, precise, well-constructed and devoid of gimmickry. And for that we love it.







## Home Theater In A Box

The idea behind the **DMP TVIX** is so simple, it's a wonder there aren't more gadgets out there like it. The TVIX is a high-capacity hard drive on which you can store all the audio, video and picture files you have on your computer. Take them wherever you want and play them on nearly any TV or stereo using the audio and video jacks on the back. Available in capacities from 80GB to 250GB, it weighs 2.6 pounds, supports most video and audio formats, and comes with a remote control. **\$239-\$359; [www.jetaudio.com](http://www.jetaudio.com)**



## Magic Eight Ball

Most pool tables look as if they were built for either a frat house basement or the game room at the Harvard Club. Is it too much to ask for a pool table with a simple, handsome design and quality construction? Brunswick, the legendary manufacturer that has been building pool tables since the time of Abe Lincoln, has launched the **Apollo** table, which the company describes as a radical design. We disagree. It's better than that. It is modern and elegant and it injects new life into a great old game. **\$3400-\$3850** (depending on size); **[www.brunswickbilliards.com](http://www.brunswickbilliards.com)**



## PREVIEW: Sony PSP

**What Is It?** Sony's PlayStation Portable is scheduled to hit our shores in late March.

**Size:** 6.7 x 2.9 x 0.9 in. **Weight:** 9.2 oz.

**Screen:** 4.3 in., 480 x 272 pixels

**Will It Work With The Games From Your PlayStation 2?** Of course not. The PSP uses an entirely new format called the Universal Media Disc. It measures 2.36 in. in diameter, holds 1.8GB and includes all the copy-protection features that big corporations love.



## Drag Racer

It's the latest, greatest thing in belt sanders. The **Black & Decker Dragster** uses a standard 3 x 21-in. belt, but has a low-profile front roller, an adjustable front handle, and an extended schnoz that can sand right up to the corner of a floor, or under an overhanging stair or lip. Plus, the front hood flips up, so you can use the top of the belt to get into tight spots you would otherwise have to sand by hand. **\$70; [www.blackanddecker.com](http://www.blackanddecker.com)**

## The Wake-Up Call ▶

Nothing jumpstarts the day better than a hefty dose of caffeine, but when French roast alone isn't enough to wake you, a shot of color can help.

Hamilton Beach's all-metal **Eclectrics coffee-maker** is available in red, yellow, blue, green and, if you insist, white or black. There are plenty of useful features (programmable timer, auto shut-off, accelerated brewing, etc.), but none beat the kick-in-the-pants benefits of a three-alarm-red machine. \$100; [www.hbectrics.com](http://www.hbectrics.com)



## ◀ Playback

Wait long enough, and something smaller and cheaper will come along, but for now, the MP3 size/capacity/price champion is the 20GB **Archos Gmini XS200**. It costs the same as players with one-fifth its storage, and is just millimeters and grams away from their size and weight. Plus, it is simple to navigate, has 10 hours of battery life, and it requires no installed software (just drag and drop your files, it scans and organizes music on its own). \$250; [www.archos.com](http://www.archos.com)



## ◀ Sport Utility Stroller

Shopping for a stroller these days is a little like buying your baby a car. There are makes and models to fit every lifestyle and a bewildering assortment of features. By this analogy, the **Bugaboo Frog** is the luxury SUV of strollers—aggressively styled, expensive, and extraordinarily overengineered for the day-to-day business of strolling. It has fat tires, shock absorbers, a handbrake and even mosquito netting. Designed for both off-road and urban use, it is available in eight colors, and it changes from a bassinet to a traditional stroller to a two-wheeled rickshaw with a few quick adjustments. \$730; [www.bugaboo.us](http://www.bugaboo.us)



## SMART PHONE Showdown

They make calls, they e-mail, they keep you organized and help you socialize, and the latest generation of smart phones loads more features into compact packages. We sent three phones to cellphone expert **Kent German** of **CNET.com** for a head-to-head.

### palmOne Treo 650 (\$599 from Sprint PCS)



**Good Calls:** This update to the hugely successful Treo 600 not only offers Bluetooth—sorely missed on its predecessor—but also has a vastly improved screen, a faster processor (312 MHz), a redesigned full keyboard and a camera.

**Hang-Ups:** Memory size (23MB) is a bit low.

### RIM BlackBerry 7100t (\$300 from T-Mobile)



**Good Calls:** Though BlackBerry devices have long been a smart-phone favorite, the new BlackBerry is a different breed. Its redesign makes the handset smaller and more portable. And, it has a vivid color screen, Bluetooth wireless functionality and a speakerphone.

**Hang-Ups:** No full keyboard.

### Audiovox PPC6601 (\$630 from Sprint PCS)



**Good Calls:** With its large touchscreen, the PPC6601 looks more like a PDA than a phone. Yet it offers more than meets the eye. An innovative sliding design exposes a full keyboard, and features include Microsoft Pocket PC 2003, 128MB of memory and a speakerphone.

**Hang-Ups:** Hefty at 7.4 ounces, keyboard is cramped.

## 3M Command Strips

### Mission:

These sticky strips and their companion hooks sell for about \$3 apiece and claim to hold anywhere from 1/2 to 7 1/2 pounds. We suspect that 3M is selling its signature adhesive short—and we're willing to break a few hooks to prove it.



### Results:

We started with Model 1703 Large Hook (shown), which was rated for 5 pounds. As we progressively added weight, the hook's plastic finger bent and strained. At 32 pounds it finally snapped, but the adhesive remained on the wall. In a second test, another Large Hook held 32 pounds, but this time it broke free intact. We tried yet again with Model 17081 Designer Medium Hook, which looked sturdier, even though it was rated for only 3 pounds. The Designer Hook also held 32 pounds before tearing free and taking a chunk of wall with it.

Finally, we refined the test yet again with the Designer Hook mounted to unrippable plastic laminate. Our last test proved the most impressive. The Command strip held 39 pounds before snapping free and shooting the hook 12 ft. across the room.

### Conclusions:

There are, of course, other unexplored parameters (we didn't, for instance, leave the weights hanging overnight), but there's little doubt that 3M's Command strips are far stronger than the package states. Should you hang an anvil off one of these things? Probably not. A tool belt? No problem.

### Methodology:

1

Prep surface by wiping with rubbing alcohol. Peel strips and affix to hook, then stick hook to wall. Wait 1 hour to build strong adhesion.

2

Using nylon twine, suspend 3- and 5-pound free weights one at a time. Wear safety goggles.

3

Run to a sporting goods store, buy more weights. Continue adding ... plates ... until ...

4

...Crash! Clang! Thunk! Count number of weights on floor, get next hook, try again.

**FOOD AND FAMILY.**  
**The 2 sources of cholesterol.**



Grandma Ethel 9/02

**VYTORIN**

**treats them both.**

You probably know that cholesterol comes from food. But what you might not know is that your cholesterol has a lot to do with your family history.

VYTORIN treats both sources of cholesterol. When diet and exercise aren't enough, adding VYTORIN can help.

VYTORIN helps block the absorption of cholesterol that comes from food *and* reduces the cholesterol that your body makes naturally. And VYTORIN can dramatically lower your bad cholesterol 45%–60%.

(Average effect depending on dose. 52% at the usual starting dose.)

**Ask your doctor about VYTORIN.**

**Important information:** VYTORIN is a prescription tablet and isn't right for everyone, including women who are nursing or pregnant or who may become pregnant, and anyone with liver problems. Unexplained muscle pain or weakness could be a sign of a rare but serious side effect and should be reported to your doctor right away. VYTORIN may interact with other medicines or certain foods, increasing your risk of getting this serious side effect. So, tell your doctor about any other medications you are taking.

To learn more, call  
1-877-VYTORIN or visit [vytorin.com](http://vytorin.com)

Please read the Patient Product  
Information on the adjacent page.



Merck/Schering-Plough Pharmaceuticals

To find out if you qualify call 1-800-347-7503.

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**VYTORIN**<sup>TM</sup>  
(ezetimibe/simvastatin)

**Treat the 2 sources of cholesterol.**

## VYTORIN™ (ezetimibe/simvastatin) Tablets

### Patient Information about VYTORIN (Vi-tor-in)

Generic name: ezetimibe/simvastatin tablets

Read this information carefully before you start taking VYTORIN. Review this information each time you refill your prescription for VYTORIN as there may be new information. This information does not take the place of talking with your doctor about your medical condition or your treatment. If you have any questions about VYTORIN, ask your doctor. Only your doctor can determine if VYTORIN is right for you.

#### What is VYTORIN?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. It is used for patients who cannot control their cholesterol levels by diet alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight.

#### Who should not take VYTORIN?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For a list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.

VYTORIN is not recommended for use in children under 10 years of age.

#### What should I tell my doctor before and while taking VYTORIN?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle breakdown resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine

- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin and clarithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

#### How should I take VYTORIN?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

#### What should I do in case of an overdose?

Contact your doctor immediately.

#### What are the possible side effects of VYTORIN?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache and muscle pain (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with either ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), and rash; inflammation of the pancreas; nausea; gallstones; inflammation of the gallbladder.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is not a complete list of side effects. For a complete list, ask your doctor or pharmacist.

#### General Information about VYTORIN

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: [vytorin.com](http://vytorin.com).

#### Inactive ingredients:

Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hydroxypropyl methylcellulose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

Issued July 2004

 MERCK / Schering-Plough Pharmaceuticals

Manufactured for:  
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Pharmaceuticals  
North Wales, PA 19454, USA

By:  
MSD Technology Singapore Pte. Ltd.  
Singapore 637766

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**iPod killer?**  
Not yet. But new  
Portable Media  
Centers do combine  
music and video in a  
go-anywhere device.

# Media Mogul

Seven days with Creative's new PMC leaves us interested—but not sold. **BY REBECCA DAY**

**I've been auditioning the new Creative Zen Portable Media Center (PMC) for a week now, and I've been reacting a lot like my cats do when I bring home a new toy. First came infatuation, then annoyance, followed by a period of boredom and finally renewed curiosity. In the end, I guess, sometimes I'll want to play with it, sometimes I won't.**

Creative's Zen is a \$500 handheld device that uses a new Microsoft platform for dragging video, music, and digital pics off a PC and dropping them onto a device you can carry around. The files can be music you've ripped from CDs, family movies stored on a PC or video downloaded from the Internet

or TV. The Zen is the first PMC to come to market; nipping at its heels are models from Samsung and iRiver.

All PMCs will have a few things in common: They'll use the Microsoft interface, offer a screen size of 3.5 to 4 in. and carry enough power to play one or more movies without a recharge.

I was impressed right away by the Zen's glossy black finish, 3.8-in. display and minimalist button array. But to be honest, I didn't really see where it would fit into my life. It weighs 12 ounces, so I can assure you that it's not coming to the gym—unless for use as a free weight. Instead I'll take my 3.2-ounce Rio Carbon music player, which gives me access to a thousand of my

favorite songs. If I were a train commuter, I might want to watch the previous night's "Daily Show." But I'm not.

When I did find the time to use the Zen, I quickly decided that the 7 hours of battery life for video or 22 hours of music playback is an okay tradeoff for its hefty weight. That's enough staying power for three movies from Logan to LAX. Impressive—but there's a catch: Not much movie content is available. Although the Zen, like all PMCs, uses Digital Rights Management technology to protect against piracy, Hollywood is still nervous about releasing movies for PMC download.

The paucity of options really hit home when I went to redeem the "two free downloads" coupon from CinemaNow ([www.cinemanow.com](http://www.cinemanow.com)) that was included with the Zen. CinemaNow is one of the few legal sources for movie downloads. My search for "Rear Window" and "American Graffiti" came up empty, and I soon realized there wasn't much I was interested in. I settled for a concert video of the Brian Setzer Orchestra in Japan but there

(Please turn to page 35)

# Inner strength



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was nothing else I wanted—even for free. As a second problem, the CinemaNow pricing plans proved ridiculously confusing. Despite signing up for a free trial, I was charged \$2.99 for a movie that ended up not working with the PMC format.

For downloading, I used a Media Center PC, which comes equipped with a TV tuner card to record and play TV programs. (Though you can use any Windows XP computer running Windows Media Player 10—a downloadable vault for music, images, video and TV—you'll need to buy the tuner card separately to get the most out of your PMC.) Transferring music and the downloaded video was a breeze and operating the device was no-brainer simple. Four buttons at the top of the device access your favorite music, playlists, videos and slide shows in presets like those on a car stereo. That's important when you're navigating thousands of pics and tunes. Come to think of it, the device could use a few more of these preset buttons.

But watching TV is what Microsoft had in mind, and the portable device gives you a useful outlet for the TiVo-like functionality built in to Media Center PCs. Unfortunately, transferring

TV shows to the Zen wasn't nearly as smooth as grabbing pictures and music. I recorded a few shows on my PC, but they didn't show up in the My TV section of the Windows Media Player 10 library the way music tracks obediently filed themselves under My Music.

After I located the 30-minute Sunday news program I had recorded, I was prompted by software to convert the program into a code the Zen could read. This took an absurd 21 minutes—enough time for me to watch the program at home. The screen offers very good resolution, but the audio was a bit out of sync.

So, after playing with my new toy for a week, I submit these verdicts. The technology is innovative and intriguing. I like being able to store pictures and TV shows on a portable device, but there are still kinks to work out. Thumbs up for the portable photo album, which is a great way to get my pics out of the PC and in front of friends and family. For music, I'll stick with the lightweight Carbon, which is much easier to slip in my pocket. The bottom line: When Creative comes out with a sub-\$200 PMC that's half the weight, I'll be all over it like my felines on a catnip mouse.

**PM**

## Head to Head

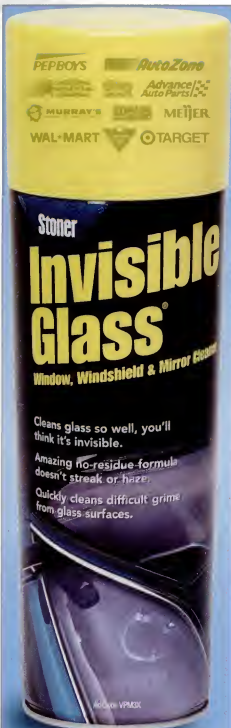
### SO YOU WANT TO TRY A PORTABLE MEDIA CENTER (PMC)?

Products are now available from Creative Labs, iRiver and Samsung that import video, TV, pictures and music from the Windows Media Player 10 library of your PC. Better than a personal digital assistant for playing video, these PMCs boot up faster than a full-blown PC, and most have a longer battery life than either your laptop or MP3 player. A PMC is easier to cart around than a portable DVD player.

But is the PMC Microsoft's answer to the all-conquering iPod? Michael Gartenberg, vice president of market research firm Jupiter Research, doesn't think so. "People are calling PMC an iPod killer and we don't think that's the best way to frame the equation," he says. Its advantage really is being able to watch any type of video—all on a small, portable player.

#### SPECS FOR PORTABLE MEDIA CENTERS

	Price	Weight	Screen Size	Battery Life
<b>Creative Labs Zen Portable Media Center</b>	\$500	12 oz.	3.8 in.	7 hours video or 22 hours audio
<b>iRiver PMC-120</b>	\$500	9.8 oz.	3.5 in.	5 hours video or 14 hours audio
<b>Samsung YEPP YH-999 Portable Media Center</b>	\$550	7.96 oz.	3.5 in.	3 hours video or 12 hours audio



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# Waterworks

Clean-burning four-stroke outboards churn the midsize trailer-boat market.

BY GLENN LAW

## Boat ramps on weekend mornings

buzz with promise. Families organize coolers and gear, anglers stow tackle, and uncooperative boat trailers are coaxed into the water. Then outboard motors howl as weekend helmsmen warm them up, filling the air with an acrid cloud of blue exhaust. Why blue? That's the universal indicator of an old, simple two-stroke (aka two-cycle) engine burning special oil mixed with its fuel for lubrication.

Although bass, walleye and pike won't catch any breaks soon, at least that noise and smelly exhaust are fast

becoming a thing of the past. The Environmental Protection Agency requirements for cleaner outboards, which come due in 2006, and the even stricter California Air Resources Board regulations of 2001, have spawned a new generation of quieter, cleaner-running four-stroke outboard motors that are steadily supplanting two-strokes on family recreation and fishing boats.

## FOUR-STROKE REVOLUTION

Four-stroke engines, with their mechanically driven sealed-com-

**LUND MR. PIKE 17:** Just 17 ft. long, this new aluminum entry can handle a powerful 150-hp four-stroke.

bustion valvetrain, are heavier and bulkier than equivalent two-strokes. And four-stroke performance often seems sluggish when compared to the more nimble two-strokes that produce power twice as fast, or on every second piston stroke (hence the engines' name).

Four-strokes sacrifice throttle response for better emissions control and smoother running, but they don't work well in all applications. Competitive bass fishermen still prefer the two-stroke's low-end punch and higher power-to-weight ratio. "There is not enough speed and not enough torque in the four-strokes," says Paul Shore, production manager for Skeeter Boats. "They don't perform on a par with the two-strokes."

Yet, Mercury Marine helped make a dent in that attitude last year with its Verado series, the first four-stroke outboards with a supercharger under the cowl. The result is lots of response even by two-stroke standards—plus smooth, clean operation.

Boatbuilders are responding to four-strokes by altering hull design. Widening the back end below the waterline provides more buoyancy and, as a bonus, yields extra interior space. Builders are tweaking deep-V hulls, which excel at high speeds and on rough water, as well as upgrading the stable, roomy semi-V-style hulls. Center consoles and dual consoles, with a starboard driver's seat, are also being enhanced.

This year's new crop of fishing and family boats in the 18- to 25-ft. range are the popular entry point for beginning boaters, and the size of choice for serious trailer-boat fishermen. Now that builders have accommodated the new powerplants, here's a look at what's new on the water this spring.

## FASTER FISHING BOATS

Fountain Powerboats, known for its fast deep-V hulls, has parlayed its racing heritage into fishing boats,



notably on the kingfish tournament circuit where going fast means getting to the fish ahead of the competition.

Fountain redesigned its 23 Center Console fish boat this season to carry the Mercury 275 Verado (\$89,556 for the hull and motor), which the company says will push it along at 60 mph. The 23 has a deep-V hull similar to the Fountain 42-footer that was clocked at more than 170 mph last summer. The 23 is essentially a shorter version of that speedster, reconfigured with a hull that's wider than the previous 23's. It also has more cockpit and fishing space.

#### ADAPTABLE BAY BOATS

Notable in this spring's lineup is the "bay boat" phenomenon. A hybrid of center-console fishing boat and runabout, these stable, low-sided hulls adapt to just about any kind of fishing. They hit the market a few years ago and haven't stopped selling since.

Pathfinder's bay boats are exemplary in the category. The company has deepened the V into its 2200 V Tournament Edition (\$38,900 with a Yamaha F150), originally designed for inshore fishing, to handle rougher water. The firm also added voluminous live wells to suit anglers who go after striped bass. With front and rear raised casting decks and abundant rod and gear storage,



**PATHFINDER 2200 V TOURNAMENT EDITION:** Leading the way in hybrid bay boats.

fishing drives this design, but it's also well-suited for family fun. Rated for up to 250 hp, with a Yamaha VZ200 and two people, it hits just over 57 mph.

#### FAMILY FISHING

This year, builders once known for specializing in bass boats are turning their attention to multiuse recreation and fishing boats, with a couple of venerable brands offering family-focused models.

Ranger Boats introduced the versatile 1850 Reata (\$28,500 with a Yamaha F150). "We've been building deep-Vs in tournament-type boats," says Randy Hopper, president of Ranger. "We wanted to build a family boat that would take on those same qualities. The Reata was built to accommodate the heavier motors people are buying and still maintain driveability."

The 1850 is rated for up to 175 hp and is designed to carry both a bow-mount trolling motor for shoreline fishing and a kicker—usually an 8- to 10-hp outboard—alongside the main motor for deep-water trolling. The walk-through windshield protects passengers and allows bow-to-stern access for both anglers and waterskiers. In recognition of the boat's family chores, the design includes floor lockers to store skis as well as rods and tackle, and a recirculating live well to keep bait frisky.



**RANGER 1850 REATA:** Designed to tackle both fishing and family needs.



**SKEEPER WX1880:** The 5-in.-higher transom keeps water out when backtrolling for walleye.



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## DRIER FISHING BOATS

Skeeter, which built the first fiberglass bass boat in 1961, launched a new walleye and multispecies fishing boat for 2005 in the WX1880 line (\$33,270 with a Yamaha F150). The 1880's semi-V hull favors the needs of freshwater fishermen with an extra 5 in. of transom to keep the water out and the motor dry when backtrolling, a popular method of presenting baits to walleye, stripers and crappie. With 90 in. of beam carried clear to the back, there's added interior space and enough lift to carry up to a 200-hp motor plus a kicker, for trolling.

## MORE STORAGE

Price, durability and a high-sided design with twin consoles and windshields for rough conditions have made Lund a leader in freshwater fishing boats. This year's Mr. Pike 17 (\$11,800 for the hull) continues with the successful 16- and 18-ft. models in the same line. There is enough flotation in the hull to carry a 150-hp four-stroke plus the trolling kicker motor.

"Our most popular setup is with a 115- or 150-hp engine, which can go between 41 and 45 mph," says Keith Boyne, who oversees product development for Lund. Improvements to this 2005 version include better storage. The 7-ft. under-floor rod locker, for example, can hold a full tournament's worth of rigged gear.

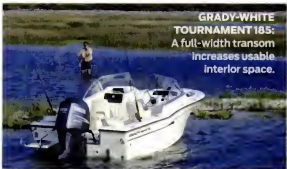
## LUXURIOUS FAMILY FISHING

If creature comforts are important, and those creatures are family and friends with some fishing on their minds, there are a couple of new four-stroke designs that put comfort first.

The interior layout of Grady-White's new dual console Tournament 185 (\$35,070 with a Yamaha F150) offers more passenger protection



**BOSTON WHALER 235 CONQUEST:** It's the shortest of four models in the line.



**GRADY-WHITE TOURNAMENT 185:** A full-width transom increases usable interior space.

and seating than a center console. Upgrading to the larger 225 model brings a bracket-mounted outboard on the full-width transom, which gives the feel of a 24-footer to a boat that's 2 ft. shorter. A collapsible bench seat along the transom provides convenient passenger space when running, then folds flush and out of the way when the rods or wakeboards come out. This is a design problem builders have been trying to get right for a long time, and it's not surprising that innovative Grady-White came up with a worthy solution.

With only slightly less fishing pedigree and a big reputation for comfort and safety—these hulls float even if you cut them in half—the Boston Whaler 235 Conquest (\$62,500 estimated, with a Mercury OptiMax 225) is a family cabin boat tweaked to handle the Mercury Verado 225/250 and carry a dozen passengers. Retooling extended the starboard side of the hull, where there's a swim platform and collapsible boarding ladder. The port transom corner holds a small live well for bait. The forward cuddy cabin and windshield offer protection from the weather when needed, making the 235 a great choice for a family's first venture into boating.

PM

The longer you wait

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**2005 F-150**





# Winning The Cyber Bowl

When it's third and long, NFL coaches call in the geeks. **BY ALLEN ST. JOHN**

**As the cameras pan to the sidelines** on Super Bowl Sunday at Alltel Stadium in Jacksonville, Fla., fans will be reminded of a few perennial mysteries. Why is the head coach wearing that ridiculous jacket? Why does he let them put ice in the cooler that's going to get dumped over his head at the end of the game? And whom, exactly, is he listening to over that headset?

The answer to the last question is: more people than you might expect. While football purists still get misty recalling a solitary strategist in a fedora scribbling X's and O's on a blackboard, that image of the head coach as out-dated as that of every rookie quarterback calling his own plays.

"The advances have been pretty remarkable over the last 20 years," says Fox Sports analyst and Super Bowl-winning quarterback Troy Aikman. During the game, the head coach talks wirelessly with all his assistants on the sidelines. He's also linked, through a hard-wired router, to more staffers—

often the defensive coordinator and the running backs coach—in a box above, where they have a bird's-eye view of the opposing team's formations. These coaches also monitor a TV broadcast feed, to advise the boss on whether to challenge a referee's call.

Most fans know that today the head coach—or sometimes the offensive coordinator—dictates plays via an earphone built into the quarterback's helmet. But the communication goes further. The NFL allows the channel to remain open until the play clock runs down to 15 seconds, so the coach can provide running commentary as the QB approaches the line. "He'll say,

**BEYOND BLACKBOARDS:** Game planning in the NFL—and among many NBA and NHL teams—relies on digital video systems that can cost as much as \$750,000.



PHOTOGRAPH BY BILL FRANKS/SPORTS ILLUSTRATED

(Please turn to page 44)





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"This is what the other teams like to do in this situation," or "Make sure to tell a receiver to come off the line strong" on a particular route," explains Aikman.

It wasn't long ago that familiar veterans such as Joe Montana, John Elway, and Aikman himself dominated football each January. In recent years, the former Dallas star contends, the added input from the sidelines has helped a larger cast of QBs—such as Tom Brady, Jake Delhomme, Trent Dilfer and Brad Johnson—make it to the Super Bowl.

The link to the coaches has the biggest impact in late-game, no-huddle minutes—like those that decided New England's Super Bowl wins in 2002 and 2004. "In that situation, you don't have time to get a signal from the sidelines, but now as the quarterback is running up to the line, the coach is giving him the play," Aikman says.

All these signals are encrypted, but there have been problems. During one Super Bowl, a vendor had rigged a cell-phone to talk to his crews on the same frequency as the coach-to-QB communications. "It becomes a juggling act," says Jay Gerber, who heads the league's frequency-coordination team. For Super Bowl XXXIX, when everyone

**"BELICHICK TO BRADY. COME IN, BRADY": On the field, communication is a one-way street; QBs have earphones, but no mics, in their helmets. NFL headsets went completely wireless in 1998.**

from broadcasters to cheerleaders will use wireless devices, Gerber's crew will juggle at least 1200 frequencies, up from 300 in a regular season game.

But all this game-day technology is a figurative drop in the Gatorade bucket compared to what happens earlier. Each team prepares with a state-of-the-art digital video system—and 27 of the league's 32 teams have chosen a Pinnacle Systems SportsPro setup that's based on the Avid system ubiquitous in Hollywood editing rooms.

The system can store up to 5 terabytes of data—about 1200 hours of game footage. The raw information comes from the NFL's game-exchange program, but each team has its own techies who mark each play with a variety of data points, from field position to the weather. "Guys who are really good can break down a game in an hour and a half," says Pinnacle team

The input from the sidelines has helped a larger cast of QBs—such as Brady, Delhomme, Dilfer and Johnson—make it to the Super Bowl.



sports sales manager Bob White.

The result is that a coach can quickly call up, for instance, every play that the Pittsburgh Steelers have run on third down and 3 yards or more, against a 40-over-front in cover formation, from the left hash mark, inside the 30-yard line ... in the rain.

The coaches can't take these digital planning tools to the sidelines—NFL rules force them to make do with printouts on game day. But the information explosion has transformed planning. For instance, coaches now prepare customized DVDs, complete with telestration and voice-over, that each player can watch at home. That's a far cry from the old days when teams would gather to watch grainy, fragile 8mm film in a darkened room. Back then, recalls Aikman, "the humming of the projector was the only thing that kept a lot of the guys awake." **PM**

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# The Seoul of the Southwest

Hyundai adds another desert city to its SUV family.



Since 1998, U.S. Hyundai sales have more than tripled and the brand is now the fourth best-selling import in the country. But, the Korean automaker still has a slew of new vehicles coming to help maintain momentum. The opening salvo is the 2005 Tucson SUV.

The Tucson is smaller than Hyundai's original SUV, the Santa Fe, but not by much. It's slightly shorter in length and height than a Ford Escape but it sits on a longer wheelbase.

## "On rough roads, the Tucson chassis was rock solid and quiver-free."

Based on reinforced Elantra passenger-car underpinnings, the Tucson has a four-wheel independent suspension with MacPherson struts up front and a multilink design in back. The result is a vehicle that's not quite as athletic

as some in the segment but one that still certainly has a substantial feel. On the rough fire roads near the Oregon coast where we sampled the Tucson, the chassis was rock solid and quiver-free. And the compliance over downtown Portland potholes was sedanlike. Under the hood is a choice of a 140-hp 2.0-liter four-cylinder or a 173-hp 2.7-liter V6 borrowed from the Santa Fe GLS. The V6 is adequate but won't win many stoplight drag races against some of its brawnier SUV competi-

tion. Front-wheel drive is standard but BorgWarner's seamless electronic all-wheel drive is only \$1500 away and makes the most of the Tucson's 7.7 in. of ground clearance.

Part of Hyundai's recent success



Cabin materials and quality are on a par with the best vehicles from Japan.

is due to the company's focus on using better-quality materials for the vehicles' interiors. Every Tucson comes with a fold-flat rear seatback and a multitude of tiedowns and hooks in the cargo areas, as well as six airbags, four-wheel disc ABS and electronic stability control as standard equipment. The price for a base GL starts around \$17,499, the midrange GLS goes for just under \$20,000 and top of the line LX models begin at \$21,249. Ben Stewart

(Please turn to page 48)



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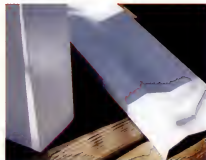
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With more room and performance, the Boxster gets its first redo.

## Boxster Opens Up

Nearly a decade after Porsche's Boxster was introduced, it is getting its first substantial revisions. For 2005, the Boxster and more powerful Boxster S have received a complete restyling that brings with it more space inside. Porsche engineers claim that 80 percent of the parts are new. Exterior styling changes include a wider wheel track, repositioned headlights, more prominent rocker panels, larger air scoops and a more rounded profile. The change of shape drops the aerodynamic drag rating from 0.31 to 0.29 in the base model (0.30 in the S), an improvement aided by a nearly complete underbody sheet.

Boxster's soft-top folds into a smaller space than before to enlarge rear cargo capacity. Safety improvements include optional larger brakes made of a ceramic material, a stability control system that allows some rear-wheel breakaway on acceleration, a 1-in.-higher rollover bar and airbags that wrap up over the passengers' heads from the two doorsills. Two horizontally opposed six-cylinder engines are available, the 240-hp 2.7-liter for the base model and a 280-hp 3.2-liter for the S. Prices start at \$42,600 for the base model and \$51,600 for the S. *Jim Dunne*



Caddy's newest rocket is due in the fall of 2005.

STS chassis is up to cashing the checks that the engine can write, the car has 18-in. front and 19-in. rear tires, a stiffened chassis and upgrades to the brakes, steering and antisway bars. You'll recognize the STS-V by its fine-mesh grille, lower front and rear fascias and lower rocker covers. Other identifying marks include 10-spoke wheels, and a supercharger bulge in the hood. *J.D.*

## Gentlemen's Express

Cadillac anoints the STS model with its high-performance V-Series stamp in a 440-hp model that has a new Hydra-matic six-speed automatic transmission. To ensure that the rest of the

# Spy REPORT

DETROIT By Jim Dunne

## Going To The Mountain

Mercury will offer a minor facelift and slight alterations to the rear of its Mountaineer for 2006. The freshening includes the grille, lower air intake and running lights in the front, and redesigned lights and bright trim at the rear. Hard to see in this photo of a running prototype are new wheels, as well. Mirror shape is new, too, indicating an aerodynamic move to lower cabin wind noise levels. Mountaineer's revisions match those of the 2006 Explorer, its Ford sibling, where front- and rear-end treatments are only slightly adjusted for the model change.



The '06 Mountaineer shares a lot with its Explorer sibling.

## The Shrinking Lincoln

There's been a lot of industry buzz about the reshaping of Lincoln into something less than a true luxury brand. Well, a look at the 2007 Aviator adds fuel to that debate. The model is based on a small Mazda chassis—almost nothing that you see in this vehicle is Lincoln. But underneath is an upscale V6 engine, four-wheel drive and all the chassis control amenities of a luxury crossover. The Aviator will downsize but it will not simply be a modified version of the Ford Freestyle. Instead, Lincoln will borrow heavily from the small Mazda van chassis and

(Please turn to page 50)

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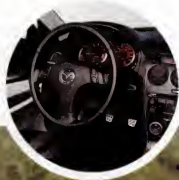
## Gentlemen's Express, II

**Mazda would rather you thought** of its new 2005 MazdaSpeed6 as a "performance sedan" than simply another entry in the hot sport compact "boy racer" market. Starting with a reinforced version of the Mazda6 sedan chassis, Mazda's engineers added all-wheel drive and a six-speed manual transmission, upgraded the suspension and brakes, and added large 215/45R18 tires. Oops, almost forgot. They also dropped in a turbocharged, direct-injection four-cylinder engine. The 2.3-liter Four pulls dramatically, developing a rush of torque at the 3000-rpm sweet spot. Though Mazda engineers were still tweaking the engine as we went to press, the goal was 272 hp and 280 lb.-ft. of torque. We like those kinds of goals.

To manage that output, the electronically controlled all-wheel-drive system measures steering wheel position, yaw rate and wheelspin as it diverts power from the front to the rear wheels to a maximum distribution of 50/50. The independent suspension consists of double

wishbones up front and a multilink setup in the rear and it all works to keep the tires planted firmly when driving quickly.

Exterior design changes are modest, but not so subtle as to mask the true high-speed nature of the Speed6. Up front, a larger air intake in the lower bumper fascia feeds the engine intake and accessories. A new bulge in the center of the hood feeds air from the top of the grille into the turbo intercooler. Four circular forms in the headlight complex house the high and low beams and turn signals (one is a dummy). Foglamps are moved to a position on the lower fascia. Mazda6 credentials at the rear are a modest wing on the decklid and large dual-exhaust outlets. At the side a minor appliqué adds texture to the rocker panel. Mazda offers the Speed6 as the flagship vehicle in its sedan lineup with prices ranging from \$27,000 to \$28,000. J.D.



Squat stance and serious drill-steel pedals hint at the nature of this sedan.



build an all-new appearance. Two keys to identifying this early test vehicle are the wider fender openings that accept larger wheels and the wheels themselves, lifted from the current Aviator design.



It may look like a Mazda, but it's a testbed for the '07 Lincoln Aviator.

## Talking Tahoe

Shoppers will see a number of styling changes when the 2006 Chevrolet Tahoe hits showrooms. All of the exterior sheetmetal—except for the roof—is new. Up front is a larger grille with a wider, taller section for air intake and markedly changed headlight shape—large, trapezoidal shapes house the driving lights and the amber turn signals. Front bumpers dip down in the center to make space for the deeper grille while housing small, round running lights. A raised hood section blends in with the taller grille. Chevy continues its horizontal bar grille theme, with a bar that stops between the headlights instead of stretching the full distance from side to side. At the body sides both front and rear wheel arches are more pronounced, and carry the angular theme of the grille in their larger shapes. A minor point, except to Tahoe aficionados, is the deletion of the grilles on the D-pillar.



Despite layers of covers, we can see that this is the 2006 Chevy Tahoe.

(Please turn to page 52)



1923WATCH.COM

"I collect timepieces. When I received my Steinhausen, I knew from the look, feel, and quality of the watch that this would be one of my favorites. I have spent thousands of dollars for inferior watches. It will be my gift of choice this holiday season." Sol S., Mt. Vernon, NY



# So rare that only a handful were made in 1923

In 1923, a Swiss watchmaker crafted the most advanced watch of its time. After 80 years, the Steinhausen watch has finally been "reborn," preserving its mastery of technology and classic design. Once only displayed in high priced collections, this rare timepiece from history can now be yours.

**S**tep back in time to Steinhausen, Switzerland circa 1923. A master watchmaker works for months, trying to create the world's most perfect watch. Finally he succeeds—the first of its kind to display the date, day and month, and the only one to designate AM/PM.

## Collectors Pay Thousands \$\$\$\$

He makes a limited number of these distinctive handmade timepieces, which eventually find their way onto the wrists of only the world's most distinguished gentry. Today, collectors are willing to pay thousands of dollars to add one of these original Steinhausen masterpieces to their own collection.

## Reborn After 80 Years

Until now, that was the only way you could own a Steinhausen, still one of the world's rarest and most prized wristwatches. But for the first time in 80 years, the original Steinhausen masterpiece is now being painstakingly reproduced for modern day collectors. Still manufactured by hand, this 21st-century reproduction carries the same graceful styling and features as the original. The scratch-resistant crystal comfortably rests in a surgical grade stainless steel case and bezel, which provides the ultimate in precision and protection.

## Powered by You

This handsome timepiece has been updated with a kinetic automatic movement that is powered by the motion of the wearer's arm, so the watch never needs winding or batteries.

## Hand-crafted Elite Movement

The Steinhausen movement consists of 185 parts, that are assembled entirely by hand. To prevent wear on gears, fine watches use tiny gemstones to reduce friction. The Steinhausen features up to 35 jewels, 15 more than most of the worlds elite watches. The movement is then rigorously tested for flaws and accuracy. Only 6% of the movements made ever meet the stringent requirements to be placed in this noble timepiece, making the Steinhausen one of the most accurate in the world.

## Adapted from Swiss Technology

A Swiss engineered movement comparable to the Steinhausen has never been produced at this low price. Each watch comes housed in a handsome storage case and includes two interchangeable leather wristbands in black and brown.

## \$14.95 "Wear It and Love It" Trial Offer

Until now, most of us couldn't afford an original 1923 Steinhausen. For a limited time though, the manufacturer has decided to offer this masterpiece of technology and design to watch lovers worldwide "risk free."

In fact, they are so confident you'll love the Steinhausen masterpiece, they want you to try it on your wrist for a full 30 days for only \$14.95 plus s&h. Experience this unparalleled value for thousands less than comparable collectable watches. If not satisfied, return the Steinhausen for a full refund of the trial fee.

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*Kinetic movement...never needs batteries...never needs winding!*



## THE HISTORY OF WATCH MAKING

1868	Steinhausen masterpiece is created	1st Automatic movement in a wrist watch	1953	Girard-Perregaux introduces the Swiss quartz watch	2003
Patek Philippe makes first wrist watch	1923	Lips produced the first battery powered watch	1966	Steinhausen masterpiece is reproduced for first time	

\*\$14.95 Trial Offer entitles customers to receive one of our Steinhausen watches for review for 30 days with the right to return the watch to their period with no additional charges (minus s&h). Customers who elect to keep the watch will be billed the corresponding purchase price plus applicable taxes for the model selected either in full or through available payment options.





Weighing 3100 pounds and making 500 hp, the Z06 is going Viper hunting.

## Snake Biter

With the new Z06, Corvette engineers aimed directly at the Viper. To start, there's the all-new 500-hp LS7, 7.0-liter normally aspirated engine that makes 475 lb.-ft. of torque. Backing it up is a Tremec six-speed manual. However, to deal with the added stress, both the transmission and the beefy new rear differential are oil-cooled. Getting the power to the pavement are massive 355-30/19 rear tires and 275-35/18 fronts hiding giant discs clamped by six pistons in the front and four in the rear. All this is bolted to essentially the same frame the current C6 Corvette employs, but crafted in aluminum. Other weight-trimming gets the new Z06 to just under 3100 pounds. Chevy claims it should hit 60 mph in the 3-second range, the quarter-mile in 11, top out well north of 190 mph and pull greater than 1.0 on the skidpad. We need one, like right now. *B.S.*

## Fast, Loud and Under Control



**The limited-edition 2005 999R** is a lightweight, high-performance version of Ducati's flagship 999 sportbike. The 999R handles like it's hard-wired to your cerebral cortex—response seems almost telepathic. But it sure isn't comfortable. The seat is wafer thin and the riding position will give anyone short of a triathlete a herniated disc in less

Ducati will import about 300 of these \$29,995 bikes in '05.

than 200 miles. Regardless of your Body Mass Index, since the exhaust is routed under the seat, your butt and thighs will cook like burgers on a barbecue. But hey, this thing is so much fun you won't care about your roasted rump.

Nestled inside the bike's trestle frame sits a 999cc twin-cylinder that cranks out a pavement-rippling 150 hp at 9750 rpm. Full of fluids, the 999R weighs only a few ticks over 400 pounds. And that means triple-digit speeds can happen before you blink—accompanied by a more magical exhaust note than that of any bike we've ridden recently. *B.S.*

## Spy REPORT

### More Mercury

Here's a peek at the final model in Mercury's sedan line: the 2007 Milan, sister to Ford's Fusion. Mercury styling cues include the waterfall grille and swept-back headlights. However, as this photo shows, the Mercury version carries virtually all of the Fusion's sheetmetal without change. One of an array of new models from Ford Motor Co. to be built on the Mazda6 platform, the Milan joins the Montego, Grand Marquis and Sable in the lineup. Mercury is expanding its truck lineup by introducing two more vehicles in the same time period, a Ford Freestyle clone and the Mariner SUV.



Sister to the Ford Fusion, the '07 Milan is based on the Mazda6.

—**EUROPE** By Mike Allen

### Something Hot For All The Volks

This facelifted VW R32 will debut in several months. Under its hood will be yet another version of the company's 3.2-liter V6 engine—this one will make about 250 hp. If you're wondering how we know this isn't the GTI, we've seen the view from the rear: There are two howitzer-size exhaust pipes that never adorned a factory-stock GTI. VW insiders are hinting at a 280-hp 3.6-liter version in '07.



Not a GTI, but VW's newest hot rod, the R32—due here very soon.

PHOTOGRAPHS BY JIM DUNNIE (MAZDA6), HIDDEN IMAGE (VOLKSWAGEN R32)



## Ferrari Fever

For a manufacturer that builds and sells so few automobiles, it's amazing how prolific the people at Ferrari's Maranello headquarters can be. We spotted this ragtop F430 Spider during a high-speed testing session. Like the F430 coupe, this car will be powered by a 483-hp V8. If you can wait before spending your lunch money, it should replace the 360 Modena Spider by midsummer.



The next dream from Ferrari for 17-year-old boys.

● ASIA By Ben Stewart

## A Real Eclipse

Here's an official photo from Mitsubishi of the 2006 Eclipse. The all-new sports car shares its architecture with the maker's Galant and Endeavor SUV. Under the hood will be a more powerful standard 2.4-liter four-cylinder. But power junkies will opt for the new 3.8-liter V6 that makes 260 hp and 260 lb.-ft. of torque, backed by a six-speed manual or five-speed Sportronic automatic. Expect 17-in. wheels to be standard, while top-level cars will wear 18-inchers. The optional 650-watt Rockford Fosgate audio system with an MP3 player and six-disc in-dash CD player should be enough to keep hardcore audiophiles happy.



Eager to prove it's here to stay, Mitsubishi is showing the next Eclipse.



Honda will attempt to lure back the racing crowd with this new Civic.

## Civic Minded

Our spies caught what we believe to be the next-generation Honda Civic while testing in Europe. Details on the car are sketchy but it appears the all-new Civic will return to its roots—one that enthusiasts will embrace. With a new small car based on the Japanese-market Fit taking the Civic's place as the entry-level Honda, the Civic may grow larger and more powerful. Expect the current trim variants to continue—including a second-generation Civic Hybrid. Rumors deep within Honda say the much vaunted, high-performance Integra Type R may finally make it to our shores, too. Look for the new Civic to land here next fall.

## Quality Is Job One



Still two years away, this '07 Elantra looks ready for the showroom.

Hyundai has made great strides in quality due partially to rigorous preproduction testing. That makes it easy for our stealthy spies to grab photos in the process. This car, the 2007 Elantra sedan, looks close to production-ready. The new Elantra will be larger than the current car. Expect more refined engines and top-quality interior materials—a trait the Korean automaker is getting to be known for.

## And Another Thing... Lack of Restraint

By Don Chalkin

The Insurance Institute for Highway Safety (IIHS), a lobby organization for the insurance industry, regularly conducts its own crash tests, for which it should be commended. Many of these tests don't replicate those conducted by the carmakers or by any government agency. Given the fact that these tests are often unique it's no surprise that many vehicles fail in the eyes of IIHS.

Such was the case with the head-restraint tests conducted a few months ago. These revealed that most tested cars do a poor job of protecting front-seat occupants from whiplash injuries (no word or testing on rear seaters). Most of the negative publicity was directed at "American" cars, which did worse in the tests than imports. It should be noted that the cars that did the best, from Volvo and Saab, are made by Ford and GM, respectively. Last I checked, those were still American companies. However, it's undeniable that the more familiar, mainstream brands from our homegrown makers—along with those of Japanese, German and Korean makers—in general don't do a good job of preventing whiplash injuries. Could they do better? Sure. Will they? No doubt.

But more critical is that the world's carmakers have been busily concentrating their efforts on giving us cars that protect us from dying, often at the expense of other injuries. Whiplash is a serious concern, costing us huge sums of money and very real pain and suffering for those involved. But while we're complaining about our aching necks, let's not forget to thank the world's carmakers—all of them—for designing and building vehicles that allow us to talk about the serious accident that we survived.

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# NOWHERE



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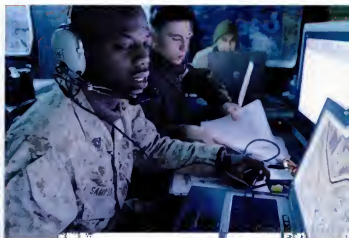
# TO HIDE

photographs by LUCIAN READ

High above Iraq's urban battlefields, tiny, remote-control spy planes—streaming video 24/7—provide a crucial edge to coalition forces. A report from the battle for Fallujah.

**SKY PATROL:** Marines of the Watchdog Squadron monitor the city of Fallujah with the unmanned Pioneer (opposite), hunting for threats.

IN A SMALL TENT ON THE OUTSKIRTS OF FALLUJAH, a dozen Marines in a unit known as the Watchdogs crowd around a pair of 26-in. monitors that show the same nighttime scene. ¶ “There goes a mongoose kid,” says Lt. Col. John “Ajax” Neumann, commanding officer and mission commander. “Stay with him.” ¶ Cpl. Phillip Saliba adjusts the zoom lens of an infrared camera on the underside of a remotely piloted aircraft circling 3000 ft. above the Iraqi city. Even from that height, the black-and-white video feed clearly shows a cyclist hunched over the handlebars, feet pumping furiously, tires kicking up a rooster tail of dust. To the Watchdogs, the rider looks like a mongoose scurrying across a field. ¶ “He’s heading for the safe house,” Saliba says. ¶ In the monochrome of the plane’s camera, Fallujah is as bright as day, yet dingy and depressing—block after desolate block of courtyard walls, squat buildings and empty streets. The cyclist swerves left and disappears under a tin roof. ¶ “We’ve already marked that location,” Neumann says. In the four months that the Watchdogs have kept Fallujah under surveillance with Pioneer Unmanned Aerial Vehicles (UAVs), they have pinpointed more than 100 safe houses used by insurgents and the mujahedeen—“muj” to the Marines. The bike riders are sentries.



"He's probably going off watch," Neumann says.

High above, the UAV holds station, turning in lazy circles, the camera locked on the safe house, where an armed guard stands watch on a patio. A few minutes later, a pickup barrels down the street. The driver brakes in front of the safe house and backs under the tin roof.

"They think if they drive fast, we might not see them," a Marine says. "With all the dust they kick up, how could we miss them?"

"Call for a fire mission?" asks Lt. J.D. Parchman, the intelligence section watch officer. "We got a positive ID on weapons. Clear violation. Has to be muj."

"Negative," Neumann says. "It's almost H-hour, and we're supporting the opening raid. Push north to the hospital."

## H-hour—19:00,

Sunday, Nov. 7, 2004, the launch of Operation al-Fajr (the Dawn). After eight months of vacillation and negotiation by the Iraqi and U.S. governments, 10,000 U.S. Marines and soldiers, along with 2000 Iraqi soldiers, are about to kick off a campaign to regain control of Fallujah, the strong point of the Sunni insurgency just west of Baghdad and the sanctuary of the Jordanian terrorist Abu Musab al-Zarqawi. An estimated 70 percent of the 300,000 residents have fled; the 4000 insurgents who remain vow to fight to the death. American and Iraqi troops need to clear them out with minimum casualties to Multi-National Forces, Iraqi Security Forces and civilians. That means detecting where the enemy is hiding, and in what strength.

For such precise intelligence, the Americans turn to units like the Watchdogs of Marine Unmanned Aerial Vehicle Squadron VMU-1 and their Pioneer UAVs. "Those muj are out there to kill our soldiers and Marines," Neumann says. "We're here to find them so our shooters kill them first."

The UAV deployment is part of the American military's increasing reliance on unmanned technology. In Iraq, this dominance of the robotic battlefield has helped limit both coalition and civilian casualties. Radio-controlled robots are used to detonate homemade bombs; tethered blimps are common at bases. About 10 types of UAVs patrol the skies, providing real-time surveillance and battle damage assessment to troops on the ground.

The 14-ft.-long Pioneer RQ-2B, which proved its worth in 1991 during Desert Storm, looks like a boxy model aircraft you might buy at Radio Shack, assemble in the garage, and fly in the nearest park for a day of fun with the kids. With

radio-controlled landings and takeoffs, just like a model aircraft, the Pioneer can loiter over targets for more than 5 hours. Circling at less than 100 mph, it provides a steady platform for a daytime optical camera and a nighttime Forward-Looking Infrared camera.

Four months before Operation al-Fajr, the Watchdogs pitched their operations tent next to a runway about 12 miles west of Fallujah and started sending up four Pioneers a day on hundreds of sorties. Whenever insurgents came out of doors, the UAVs tracked them—day after day, night after night. The Watchdogs followed one pickup from a mosque to a highway beyond the city limits, where three men with their arms bound were pushed into a ditch and shot. The pickup was then driven back into town and parked in front of a safe house. The Watchdogs tagged it for later bombing.



**SPY CAM:** At Taqaddam Airbase, near Fallujah, Iraq, a Marine polishes the lens of a surveillance camera on a Pioneer Unmanned Aerial Vehicle (UAV), which can lock on to and automatically track high-contrast targets. Marine mechanics (right) work on a Pioneer's pusher prop to prep the UAV for its next sortie.



Several times the Watchdogs monitoring the Pioneer's video feed saw pickups swerve into empty lots. The occupants would jump out, fire a few rockets and scurry off before a response attack could be launched. "We followed one pickup after it fired some rockets," says Staff Sgt. Francisco Tataje, the intelligence chief. "It swung up onto the main highway, and we had it intercepted. The driver had a perfect ID. No incriminating stuff. We gave the interrogation team a copy of our video. They called back later to say the guy confessed."

The conflict in Iraq has proved that UAVs can do more than collect data. And, with Operation al-Fajr ready to roll, the Watchdogs' billet has been expanded to include target acquisition and strike coordination. By making airborne robotic technology a common and useful battlefield tool at the lowest tactical level—regiments and battalions—the Watchdogs and similar units in Iraq have opened a new dimension in warfare.

When Neumann's crew tracks a promising target, it sends

a "story board"—a PowerPoint presentation with text, and digital photos, maps and video streams—to one of the regiments or brigades the Watchdogs support. The data also goes to the Tactical Fusion Center on the west side of town, which collects information from UAVs, companies on the front lines, electronic intercepts, agent reports and other intel. The Tactical Fusion Center then sends the information to regimental or battalion combat teams, which determine

**The infrared camera picks up two black dots behind a berm. "I confirm weapons," the analyst says. "They're shooting across the river."**



target priorities. The combat teams' Fires Sections assign the shooters—artillery, AC-130 Spectre gunships, strike aircraft or even Hellfire missile-equipped Predator UAVs.

**As the six battalions** taking part in Operation al-Fajr roll into town from the northern outskirts, the Pioneer flies to the Fallujah General Hospital, located on the west bank of the Euphrates at a great bend in the river. The Watchdogs study the twin monitors' high-contrast images, which show a line of white ghosts snaking around palm trees in the hospital courtyard and winding up onto the roof.

"Those guys are wearing packs," Neumann says. "They're friendlies. It's the Iraqi Commando Forces."

"Concur," says watch officer Parchman. "They're too disciplined to be muj."

Outside the hospital, armored cars kick up dust, their warm engines visible through the hoods as glowing white dots. The Marine 3rd Light Armored Reconnaissance (LAR) battalion is moving into position to cover the Iraqi raiders.

Lance Cpl. Robert Daniels reads a secure chat-room message that pops up on his screen. "LAR wants us to sweep across the river," he says. "Someone's firing."

"Take us east," Neumann tells the UAV pilot. "Shift from white-hot to black-hot."

The pilot takes the Pioneer across the Euphrates, while his partner tightens the camera's zoom and switches to display a negative image: Now heat-generating objects show up on the monitors as black images instead of white ones. The screen image jumps slightly and then comes into focus: two black spots moving behind an earthen berm.

"I confirm weapons," says Sgt. Jennifer Forman, an imagery analyst. "Watch their right



**THE BOOST:** Marine Watchdog Cpl. Shawn Healey (left) confers with the pilot (above) of a Pioneer who mans the radio control. A 2-second burn from a solid rocket launches the 420-pound plane. The 26-hp two-stroke engine gives it a modest cruising speed of 90 mph.

arms when they run. They're shooting across the river."

Just as the black spots bob together, the screen suddenly blooms black, then settles back into focus, showing a thick gray cloud and a scattering of small black spots, like someone in the cloud has thrown out a handful of rocks.

"Tank gun got them," Neumann says. "Picked them up from their thermals. They're scratched. Scan up the street."

The Pioneer's camera tracks up a wide, empty boulevard bordered by ramshackle warehouses, tin-roof repair shops and dingy apartment buildings. A few hundred meters from the Highway 10 bridge over the Euphrates, four dark spots are played against one corner of a large building, with three similar spots at the other corner.

"One's lying down," Neumann says. "They're manning a crew-served weapon pointed at the bridge. Tell Regimental Combat Team-1 we have targets for Basher."

The combat team agrees with Neumann's assessment that it's a job for Basher, the four-engine Air Force AC-130 circling above the city. With its 105mm howitzer cannon,



40mm cannons and 20mm rotary cannons, the gunship is a flying artillery platform. Daniels types in a grid location for the building, accurate within a few meters. Regiment sends a one-line response: Basher on the way.

A minute goes by. The four dark spots crouch in the shadows. On the screen a black ball hits the edge of the building; black chunks go flying. Another black ball hits the target, and then another and another, enveloping the spots. Using an infrared spotlight to illuminate the insurgents, Basher's pilot is pounding away with 105mm artillery shells. Gray smoke rises from the scene.

"Watch for leakers," Neumann says. "There's one now, heading north. Stay with him."

A black spot breaks out of the smoke. Against the background of the macadam on the street, the man's silhouette

**The next day**, with Maj. Kelly "Maddog" Ramshur on watch as mission commander, the Pioneer circles al Shuhada, a district the Marines have dubbed Queens. The lair of criminal gangs, terrorists and jihadists, Queens is a warren of drab concrete houses lining dirt roads, with scant vegetation. For most of the day, the Watchdogs see few lucrative targets. In midafternoon, though, the Pioneer's camera records a series of red flashes from a courtyard, which instantly catches the Marines' attention.

The half-completed building looks like a small soccer stadium, with a wall several stories high enclosing an oval courtyard. A single mortar tube in the courtyard points north toward Camp Fallujah, the sprawling command and logistics hub of the coalition operation. Every 10 minutes or so, three insurgents sprint from a few hundred meters north

of the building and disappear under the eaves of the courtyard wall. A few minutes later, they dash into the courtyard. Each man drops a round down the tube and sprints back to the house. The mortar attack breaks the usual shoot-and-scoot pattern seen during the Fallujah engagement. This mortar crew is staying and fighting.

After six rounds explode around Camp Fallujah, Ramshur takes a phone call from the Army 2nd Brigade Combat Team, 1st Cavalry Division—the Blackjack Brigade.

"Air's not available," Ramshur says to his crew. "Arty has the target."

The Marines murmur. Artillery is an area-fire weapon, not a precision instrument. But it is all that is immediately available.

**STREET LETHAL:** Marines patrol Fallujah during Operation al-Fajr. UAVs overhead provide troops with live intel.

Saliba places the crosshairs of the Pioneer's optical camera on the mortar tube and reads off the 10-digit grid on the screen. The coordinates are sent to the Tactical Fusion Center and the Blackjack Brigade.

After several minutes, Ramshur finally says, "Shot out." The Marines crane forward to watch the explosion from a 155mm artillery shell fired from nearly 3 miles away. When a large gray puff pops up a football field away from the tube, the crew measures the miss distance and types in: Add one hundred, right fifty. That is, fire the shell



stands out plainly. He runs with the speed of a sprinter.

"Ten to one he's headed for the mosque up the street," Neumann says.

Parchman watches the runner climb a wall. "He made it. Can't hit him there."

While Basher moves on to another target, the Pioneer circles to assess damage to the building. A large door in the rear slides open, and two men run around the side of the building. They quickly return, dragging a body. The Marines watch as the scene is repeated several times.

"Are they carrying a heavy weapon or a body part?" a Marine asks.

"Don't know," Parchman says. "We confirm four down. Mark this as a safe house. We'll come back later for a relook."

# DRONE ZONE

ABOUT 10 TYPES of unmanned planes provide live camera feeds to U.S. combat operations centers. Models shown here are examples of the three major types of aeronautical robots in America's growing fleet.

## Predator

**WINGSPAN:** 49 ft.  
**OPERATING ALT.:** 16,000 ft.  
**HANG TIME:** 40 hours  
**WEAPONS:** Two Hellfire-C laser-guided antitank missiles  
**MISSION:** High-risk, medium-altitude surveillance; some strike capability against ground targets.  
**ESTIMATED COST:** \$3 million



## Global Hawk

**WINGSPAN:** 116 ft. 2 in.  
**OPERATING ALT.:** 65,000 ft. +  
**HANG TIME:** 36 hours  
**WEAPONS:** Unarmed  
**MISSION:** Long-range, high-altitude target surveillance.  
**ESTIMATED COST:** \$10 million +



## Raven

**WINGSPAN:** 4 ft. 2 in.  
**OPERATING ALT.:** 100 to 500 ft.  
**HANG TIME:** 80 minutes  
**WEAPONS:** Unarmed  
**MISSION:** Low-altitude surveillance at platoon level.  
**ESTIMATED COST:** \$40,000



100 meters farther and 50 meters to the right.

Several minutes later, a large cloud of dirt erupts inside the courtyard. The crew's next command: Fire for effect.

A few minutes later, two bright orange flashes light up the courtyard, with a third about 100 meters to the south. When the smoke clears, the tube is still standing. The next volley delivers the same result—close but not effective. No secondary explosions. No visible damage to the tube.

During the ensuing lull, the three insurgents run from the safe house, pick up three mortar rounds, drop them down the tube and run back to the house.

"You wouldn't catch me playing dodge with 155s," one of the Watchdogs says.

Ramshur calls the Blackjack Brigade Intelligence Center, then tells his crew, "We're getting Predator."

Launched from a site near Baghdad, the Predator is 13 ft. longer than the Pioneer and packs a Hellfire missile with an 18-pound warhead. The most remarkable aspect of the Predator deployment is that a crew at Nellis Air Force Base in Nevada—7500 miles away—is guiding the UAV. A few weeks earlier, the Watchdogs helped a Predator destroy a moving pickup with a mounted machine gun—one robot

leading another robot to the target.

"Break, break," Ramshur says. "Predator's been diverted. Anvil has the mission. Stand by for talk on."

Anvil is the call sign for a flight of two Marine AV-8B Harrier jets flying at 19,000 ft. Meanwhile, the insurgents make another round trip sprint. Twelve rounds have been launched at Camp Fallujah—each one with the potential to add to coalition casualties. The brass wants the duel to end.

"What do you think, guys?" asks Ramshur. "The tube or the house?" "House!" chorus the Marines.

The house where the insurgents are hiding between rounds has a dome roof, a walled courtyard and an overhang at the front door, where a sentry is posted. Once the Harriers close in, Ramshur radios the details of the house's location to a Forward Air Controller, who lines up the jets.

"The house is the first one north of the vacant lot on the northeast corner," Ramshur says. "Has a dome roof. Wait—it's where that truck is. Got it?"

A truck pulls up to the house and five men walk inside, carrying something in their arms.

"Supper time," says Sgt. Roneil Sampson, an imagery analyst. "They're changing shifts. Domino's delivery."

Ramshur reads a secure text message: Air is cleared hot. Impact is less than a minute away. The courtyard door opens. A man walks to the truck and slowly drives off.

"Boot muj sent out to get the Coke," says one Marine. "Luckiest bastard on the planet."

Both video screens flash bright white, as if a fuse has blown. When the picture comes back into focus, the Marines see that the center of the roof is now a huge black hole.

"Now that's what I call a shack," Ramshur says. "Great job, Watchdogs. Great job."

*Operation al-Fajr continued for another 11 days—sector by sector, block by block, house by house—until the Multi-National Forces had secured most of the city. The death toll: 38 U.S. troops, six Iraqi troops and an estimated 1200 insurgents. By mid-December exiled residents began to return to their homes.* **PM**

A former Marine and assistant secretary of defense for international security affairs, Bing West is the author of three books. In May, Bantam Books will publish his fourth volume, *No True Glory: Fallujah And The Struggle In Iraq—A Frontline Account*. Portions of this article originally appeared in West's online diary at [www.slate.com](http://www.slate.com).

# DIESEL

v

We match the new class of cleaned-up diesels against the latest gasoline/electric hybrids. It's a green-machine showdown.

by BEN STEWART

photographs by  
DECLAN THOMAS

State-of-the-diesel-art  
common rail injection  
system



## JEEP LIBERTY SPORT CRD

### T H E S T A T S

**PRICE**—Base: \$20,700 **As Tested:** \$25,970 **POWERTRAIN:** 160-hp/295 lb.-ft. 2.8-liter turbodiesel I4, 5A **TIRES:** Goodyear Wrangler ST 225/75R16 **WEIGHT:** 4287 lb. **SUSPENSION**—F: Coil/dbl. A-arms R: Coil/live axle **BRAKES:** Disc/Disc, ABS

### TEST RESULTS

<b>Acceleration:</b>	
1/4-mile: <sup>1</sup>	17.5 sec. @ 75.7 mph
0-30 mph:	3.15 sec.
0-60 mph:	10.53 sec.
40-70 mph:	9.73 sec.
<b>Braking:<sup>2</sup></b>	
60-0 mph:	139.9 ft.
30-0 mph:	32.9 ft.
<b>Slalom:<sup>3</sup></b>	39.7 mph
<b>Dbt. Lane Change:</b>	50.0 mph
<b>Sound Levels:<sup>4</sup></b>	
@ Idle:	59.3 dBA
@ Full throttle:	79.0 dBA
@ 60 mph:	74.5 dBA
<b>Fuel Economy:</b>	
EPA:	22 city/27 hwy
PM city:	22.7 mpg
PM hwy:	31.1 mpg

With its direct-injection turbodiesel, the Liberty CRD is unique in the midsize SUV universe. From the high-riding seating position, the little Jeep feels like a much bigger, torquier rig. It's like driving a mini Dodge Ram Cummins, as opposed to the relatively carlike Ford Escape. As one tester said of the Liberty, "It has a fairly agricultural feel to it." But unlike many trucks, the Liberty is quiet. In fact, it's quieter than the Escape at full throttle. Speaking of full throttle, the Liberty really requires more of it to accelerate on a par with many of its gasoline-powered brethren. But its massive torque and well-spaced five-speed automatic are more at home on long grades than the Escape Hybrid. At the track, the Liberty was stable, neutral and secure through our handling tests. ➤ **BOTTOM LINE:** With its low-end torque and Jeep chassis, this is an ideal vehicle for the serious off-roader, boater or outdoorsman who appreciates fuel frugality.

<sup>1</sup> Best E.T., trap speed may be obtained separately. <sup>2</sup> Best stop, hot or cold. <sup>3</sup> Best speed through eight cones, 75 ft. apart. Index of transient response. <sup>4</sup> Average of two readings.

# s HYBRID

**HYBRIDS HAVE THE HYPE**, but diesels have the history. As the battle to develop a more Earth-friendly automobile heats up, both technologies offer strengths and weaknesses. By giving a gasoline engine an electric assist, hybrids squeeze more out of already efficient vehicles. But making the most of those gains requires a style of driving that makes the most of the hybrid's capabilities and a light foot.

Diesel powerplants have always been efficient thanks to their ultrahigh compression ratios and the higher energy

content of diesel fuel. Still, anyone who has whiffed the pungent exhaust of many diesels might doubt the engine's claim to green status. But, today's diesels have been engineered to burn cleaner while still delivering impressive mileage.

To give each technology a fair shake, we assembled three pairs of vehicles that are roughly equivalent—except that one is a diesel, the other a hybrid. Then our six testers spent five days putting them through their paces at our Southern California test facility. Boy, do we feel virtuous.

Tall, skinny tires are meant much more for fuel economy than boulder crawling.

## T H E S T A T S

**PRICE**—Base: \$28,005 **As Tested**: \$31,825 **POWERTRAIN**: 133-hp/129 lb.-ft. 2.3-liter I4, 94-hp electric motor, CVT **TIRES**: Continental Contitrac EcoPlus 235/70R16 **WEIGHT**: 3806 lb. **SUSPENSION**—F: MacPherson strut R: Coil/multilink **BRAKES**: Disc/Disc, ABS, regenerative assist

### TEST RESULTS

<b>Acceleration:</b> <sup>1</sup>	
1/4-mile:	17.84 sec. @ 78.3 mph
0-30 mph:	4.18 sec.
0-60 mph:	10.67 sec.
40-70 mph:	8.21 sec.
<b>Braking:</b> <sup>2</sup>	
60-0 mph:	133.1 ft.
30-0 mph:	32.0 ft.
<b>Slalom:</b> <sup>3</sup>	41.0 mph
<b>Dbl. Lane Change:</b>	48.9 mph
<b>Sound Levels:</b> <sup>4</sup>	
@ Idle:	42.5 dBA
@ Full throttle:	81.7 dBA
@ 60 mph:	72.9 dBA
<b>Fuel Economy:</b>	
EPA:	33 city/29 hwy
PM city:	28.5 mpg
PM hwy:	29.2 mpg

## FORD ESCAPE HYBRID

While the Ford Escape Hybrid is the first hybrid SUV, it will soon have plenty of company. Under light loads, the Escape can run up to 25 mph on electric power alone, and at stoplights the gasoline engine shuts down. As with many fuel-efficient cars, acceleration is not Escape's forte. But its acceleration from standstill is about on a par with the Liberty. Unfortunately, the Escape's Continuously Variable Transmission (CVT) keeps the engine working so hard that occupants are treated to a droning high-rpm soundtrack nearly every time the accelerator is depressed. But overall, it's not any noisier than the Liberty. The hybrid system adds about 300 pounds to a V6 Escape. Result: The forgiving handling and carlike ride of the regular Escape has been degraded by lots of body roll, which can be unsettling while cornering. **BOTTOM LINE:** Not an SUV for anyone going seriously off-road or towing, but ideal for someone who wants SUV versatility coupled with economy car fuel miserliness.





During the fuel-starved '70s, Mercedes-Benz had a thriving diesel car business in the United States. Decades of engineering refinement has produced the E320 CDI, which ran our track like a sport sedan. The Benz was even more impressive on long grades, chugging along with the torquey engine practically idling at 2000 rpm, easily keeping pace with the higher-revving Honda. Torque is a diesel hallmark, and the six-cylinder E320 has even more of it than its gasoline-V8-equipped brother, the E500. And that torque arrives at 1800 rpm and stays on board until 2600 rpm, which makes it mighty useful. Combine its economy with a 21.2-gal. tank and you can cruise for about 700 miles. The downside: price. You can almost buy two Accord Hybrids for the price of one E320 CDI. Hey, you get what you pay for. ➤ **BOTTOM LINE:** If you appreciate all that comes with the three-pointed star, and are eco-conscious but don't want to flaunt it, consider this Benz.

## MERCEDES-BENZ E320 CDI



Large trunk complements car's overall presence, helps compensate for rear-seat legroom.

The silent smoothness of a V8 engine in a quick-starting V6 diesel.

### THE STATS

**PRICE—Base:** \$49,075 **As Tested:** \$52,445  
**POWERTRAIN:** 201-hp/369 lb.-ft. 3.2-liter DOHC turbodiesel I6, 5A **TIRES:** Michelin Energy MXV4 Plus 225/55R16 **WEIGHT:** 3944 lb. **SUSPENSION—F:** Multilink **R:** Multilink **BRAKES:** Disc/Disc, ABS

### TEST RESULTS

#### Acceleration:

1/4-mile: <sup>1</sup>	15.36 sec. @ 90.0 mph
0-30 mph:	2.49 sec.
0-60 mph:	7.47 sec.
40-70 mph:	5.62 sec.

#### Braking:<sup>2</sup>

60-0 mph:	132.9 ft.
30-0 mph:	34.2 ft.

#### Slalom:<sup>3</sup>

43.5 mph
52.2 mph

#### DbI, Lane Change:

49.8 dBA
75.7 dBA
71.8 dBA

#### Sound Levels:<sup>4</sup>

@ Idle:	49.8 dBA
@ Full throttle:	75.7 dBA
@ 60 mph:	71.8 dBA

#### Fuel Economy:

EPA:	27 city/37 hwy
PM city:	26.7 mpg
PM hwy:	32.6 mpg

### The Best Of Both Worlds

If diesel is good and hybrid is good, why not a diesel/electric hybrid? Actually, diesel/electric combinations abound: Most diesel locomotives are really diesel/electric. There are now several diesel/electric hybrid buses operating in U.S. cities. But there are problems

with creating a diesel/electric hybrid family hauler. Diesel engines are heavier than their gasoline counterparts, creating packaging problems when coupled with an electric motor. The Dodge Ram Contractor Special offers a diesel with an electric motor. But only a handful were built. As diesels are refined and the electronics that allow smooth hybrid operation improve, we hope to see more.





## HONDA ACCORD HYBRID

Even when engine is off at stoplights, the a/c keeps running to keep passenger cabin cool.



Sophisticated V6 engine's cylinder deactivation is as much a fuel-saving marvel as the hybrid configuration.

Floor the throttle and the Accord burns its tires to pull 60 mph in 7.55 seconds. The Accord is Honda's third hybrid car, following the smaller Insight and Civic. Unlike their total fuel frugality, the idea behind this hybrid was to deliver both performance and economy. So Honda mated an electric motor to a V6 equipped with cylinder deactivation—under light-to-moderate throttle it runs on three cylinders. Since Honda's hybrid system uses the electric motor to “assist” the gas engine rather than substitute for it, the Accord sacrifices some fuel economy for performance. From behind the wheel the Hybrid seems just like any other Accord V6—much like the E320 CDI feels like any E-Class. Translation: A terrific family sedan. **► BOTTOM LINE:** This combination of gas-powered potency and sophisticated electronics makes the Accord Hybrid a sort of enviro Q-ship.

### T H E S T A T S

**PRICE—Base:** \$30,000 (est.)

**POWERTRAIN:** 255-hp/232 lb.-ft. SOHC 3.0-liter V6, 16-hp/100 lb.-ft. electric motor, 5A **TIRES:** Michelin Energy MXV4 S8 215/60R16 **WEIGHT:** 3485 lb. **SUSPENSION—**

**F:** Multilink **R:** Multilink **BRAKES:** Disc/Disc, regenerative assist, ABS

### TEST RESULTS

#### Acceleration:

1/4-mile: <sup>1</sup>	15.67 sec. @ 91.0 mph
0-30 mph:	3.02 sec.
0-60 mph:	7.55 sec.
40-70 mph:	5.60 sec.

#### Braking:<sup>2</sup>

60-0 mph:	134.8 ft.
30-0 mph:	32.7 ft.

#### Slalom:<sup>3</sup>

	44.3 mph
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#### Dbl. Lane Change:

	51.9 mph
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#### Sound Levels:<sup>4</sup>

@ Idle:	41.2 dBA
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@ Full throttle:	76.7 dBA
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@ 60 mph:	72.6 dBA
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#### Fuel Economy:

EPA:	29 city/37 hwy
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PM city:	23.9 mpg
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PM hwy:	34.7 mpg
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Direct-injection diesel engine allows precise fuel metering; turbocharger ensures adequate performance.



## VOLKSWAGEN JETTA GL TDI

Brakes provided best stopping in this group. Suspension and steering provided best handling results.

There's an all-new 2005 Jetta coming in March. But VW will continue to sell '04 Jetta TDIs like our test car for several more months. The TDI isn't as quiet as some newer diesels—except at cruising speed when it's only a smidge louder than the whisper-quiet Prius. The Jetta is slightly slower to 60 mph than the Prius, but it's slightly quicker to 30. Plus, the TDI's rush of turbocharged torque makes the Jetta feel quicker than it is. The VW just feels spunky. Hey, it's fun rowing through the gears. And it handles well, too. According to one tester, "It's the most fun car here." Fun need not rule out frugality. Through our test loop, the Jetta's fuel economy was within spitting distance of the environmentalists' poster child, Prius. Inside, the Jetta is crafted with a quality of detail befitting a luxury sedan. **► BOTTOM LINE:** For the person who cares about economy but loves to drive, the VW provides a surprisingly well-adjusted compromise of fun and frugality.

### So What?

In the end we concluded that the real gains in fuel economy were to be found in driving habits, not necessarily in either drivetrain technology. The hybrids do better in urban, stop-and-go driving while the diesels come into their own over the long haul, especially when towing or climbing grades. But diesel fuel is smelly and can be hard to find.

Hybrids may have repair and reliability problems down the road.

If you truly want to save fuel right now:

- Keep your vehicle tuned and replace the O<sub>2</sub> sensor and air filter regularly.
- Keep the tires properly inflated and all wheels aligned.
- Don't use your vehicle as a storage shed.
- Avoid excessive idling and hammering the accelerator pedal.

### THE STATS

**PRICE—Base:** \$18,670 **As Tested:** \$19,245

**POWERTRAIN:** 100-hp/177 lb.-ft. 1.9-liter

turbodiesel I4, 5M **TIRES:** Michelin Energy

MXV4 Plus 195/65R15 **WEIGHT:** 3249 lb.

**SUSPENSION—F:** MacPherson Strut **R:** Coil/torsional beam axle **BRAKES:** Disc/Disc, ABS

### TEST RESULTS

#### Acceleration:

1/4-mile: <sup>1</sup>	17.72 sec. @ 75.7 mph
0-30 mph:	3.55 sec.
0-60 mph:	10.88 sec.
40-70 mph:	9.4 sec.

#### Braking:<sup>2</sup>

60-0 mph:	122.8 ft.
30-0 mph:	31.4 ft.

#### Slalom:<sup>3</sup>

	46.8 mph
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#### Dbl. Lane Change:

	57.7 mph
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#### Sound Levels:<sup>4</sup>

@ Idle:	53.7 dBA
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@ Full throttle:	83.2 dBA
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@ 60 mph:	73.9 dBA
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#### Fuel Economy:

EPA:	38 city/46 hwy
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PM city:	31.6 mpg
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PM hwy:	53.0 mpg
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Fuel-saving details extend to choice of relatively narrow tires.

Far from mainstream, the appearance is both aerodynamic and attention getting.

## THE STATS

**PRICE**—Base: \$19,995 **As Tested:** \$25,939  
**POWERTRAIN:** 76-hp/82 lb.-ft. 1.5-liter DOHC I4, 67-hp/295 lb.-ft. electric motor, CVT **TIRES:** Goodyear Integrity 185/65R15 **WEIGHT:** 2948 lb. **SUSPENSION**—F: MacPherson strut R: Coil/torsional beam axle **BRAKES:** Disc/Drum, ABS, regenerative assist

## TEST RESULTS

**Acceleration:**  
1/4-mile:<sup>1</sup> 17.75 sec. @ 76.8 mph  
0-30 mph: 3.65 sec.  
0-60 mph: 10.73 sec.  
40-70 mph: 8.93 sec.

**Braking:**<sup>2</sup>  
60-0 mph: 127.9 ft.  
30-0 mph: 30.1 ft.

**Slalom:**<sup>3</sup> 42.2 mph  
**Dist. Lane Change:** 54.5 mph

**Sound Levels:**<sup>4</sup>  
@ Idle: 46.9 dBA  
@ Full throttle: 77.7 dBA  
@ 60 mph: 73.1 dBA

**Fuel Economy:**  
EPA: 60 city/51 hwy  
PM city: 32.9 mpg  
PM hwy: 56.2 mpg

# TOYOTA PRIUS

This is the current Hollywood A-lister. It's the hybrid that grabs all the headlines and it's one of the least expensive ways to buy into the technology—assuming you can find one. Right now demand outstrips supply. The Prius can get to 40 mph on electric power if you baby the gas pedal. But floor it and the gas engine kicks in. Though no sport sedan, it can run with the Jetta as long as the road is straight. More important to most buyers, it had no equal on our economy-test loops. Inside, the Prius has a funky futuristic style—the stubby shifter juts out of the dash, a center screen high in the dash holds the speedometer. Funky or not, the Prius oozes quality. After a few days you forget it's a hybrid and see it as a great car. **> BOTTOM LINE:** There's a reason these cars are so desirable, and it's not just the hype. The Prius is that good.

PM

# BUDGET

## travelers

Prices are falling and new features—including faster chips, built-in Wi-Fi and higher-resolution screens—are rising. What's not to love about the latest under-\$900 laptop computers? Here's our guide to the best of a bumper crop of low-priced performers.



### DELL INSPIRON 1150 \$759

**Size Matters:** The 15-in. screen is a nice desktop. But 7.7 pounds is a lot to lug around.

**Power Points:** The 2.6-GHz chip in this Dell is plenty fast, the quickest of the bunch we tested and great for high-end games and crunching huge amounts of data. The 256MB of RAM is standard for a budget laptop. Drawback: The 30GB hard drive is a bit thin. And the optical drive plays DVDs, but doesn't let you burn your own CDs.

**Live Long and...** Dell says you get 4 hours of play time, and what do you know—you do! The fact that they're not promising eternal life wins this battery a gold star.

...Prosper: \$759, for the model we tested. More RAM and a larger hard drive would have pushed the price closer to \$900.

**Bottom Line:** Power and speed make it a winner for gamers.

by Greg Sewell

Photographs by Sebastian Gollings





#### **GATEWAY M320CS \$799**

**Size Matters:** At just 5.5 pounds—complete with a vivid 14-in. screen—this is the lightest of the tested laptops.

**Power Points:** The big 40GB hard drive is more than enough for all your MP3s, games and Microsoft Office applications. And, the 256MB of RAM is enough to keep several of those programs open at once. The 1.5-GHz chip isn't the fastest out there, but it will do the trick for most basic computer functions. The CD drive lets you burn your own CDs and play DVDs, giving you a lot of useful toys under the hood.

**Live Long and...** Killing aliens while downloading music and broadcasting over a Webcam will drain your juice in a couple of hours, but the Gateway has good power-management software, giving you extra battery life for basic tasks like writing e-mail. Count on over 4 hours for most uses.

**...Prosper:** \$799, as configured here. But if you look around online, you can likely knock \$50 to \$100 off that price.

**Bottom Line:** Feathery weight—plus battery life and a hard drive to match its competitors—makes this a highly mobile choice.

#### **HP PAVILION ZE4900 \$899**

**Size Matters:** The 15-in. screen on this HP is the sharpest of all those on our laptops, making you feel like you're getting some real bang for your sub-900 bucks. At 6.7 pounds it's on the heavy side, but not backbreaking.

**Power Points:** This is the only laptop in the group that comes to the party with a top of the line intel Pentium 4 chip. Although the Pentium's 1.4-GHz clock speed makes it technically slower than the Celeron chips in the other models, it still outperforms them—offering better graphics and faster overall processing. You get 256MB of RAM preinstalled along with a nice, fat 40GB hard drive. When we got our machine, HP was giving free upgrades from a regular CD/DVD drive to one that lets us burn our own CDs.

**Live Long and...** The battery is neither weak nor remarkable, offering less than 4 hours of cordless computing.

**...Prosper:** \$949, as tested, but there was a \$50 rebate that brought it just under our \$900 target.

**Bottom Line:** A fine deal for all the included features. That big, bright screen makes it ideal for business travelers who like to sneak in the occasional DVD.



#### **ACER TRAVELMATE 2303LCI \$699**

**Size Matters:** This laptop has a good 15-in. screen and weighs in at 6.5 pounds. Didn't anyone tell Acer that low-priced computers aren't supposed to look this good?

**Power Points:** The 1.5-GHz Intel Celeron is the same chip powering the Gateway M320CS. Match that with the same 256MB of RAM, 40GB hard drive and recordable CD drive, and the two models are pretty close to identical. What separates the two? Price and style. Acer wins in both categories, and is the best bargain of the bunch.

**Live Long and...** The average domestic flight in the United States is about 3 hours in the air. The Acer will more than last the duration with 4 hours of battery life.

**...Prosper:** \$699, but if you're following our \$900 budget, you could get an extra 256MB of RAM for less than \$100.

**Bottom Line:** Large screen, decent weight, a slim case and sleek style make this Acer perfect for the fashion-conscious laptop user who doesn't want to sacrifice beauty for performance.







by ALLEN ST. JOHN  
photographs by COREY RICH

# Driving

How to  
climb  
45-degree  
slopes,  
go desert  
drifting  
and  
gobble up  
boulders  
without  
(quite)  
flipping like  
a bug.

Welcome  
to the  
weird new  
world of  
off-road,  
where the  
rides are  
fun enough  
for a  
regular guy,  
but meant  
for a  
soldier.

#### TACTICAL MANEUVERS:

The Prowler  
will be on sale  
to civilians this  
year. (Special  
Forces driver not  
included.)

## I'm strapped into the seat

of the Prowler, a kind of ATV on growth hormones, halfway up a near-vertical embankment in a little slice of desert in suburban Phoenix. Beneath my helmet and goggles, I'm staring straight up at the wide, blue Arizona sky like an astronaut bracing for blast-

off, while behind me the beefy rear tires are spinning, grasping unsuccessfully for purchase. Actually, forget the astronaut image. I feel like a cockroach frantically trying to scale a wet tile wall and awaiting a coup de grâce from a rolled-up copy of *USA Today*.

The only way I'm getting out of this is with

the help of the cavalry, the Marines or maybe the cast of "The A-Team." While no one as warm and nurturing as Mr. T is available, from the bottom of the hill I do hear from granite-jawed Rocky Senatore.

"Get off the gas," barks the Green Beret-turned-desert-driving-drill sergeant. The engine stops its desperate revving. "Now stick it in Reverse."

This doesn't strike me as a great idea, as I'm one false move from tumbling backward, tailpipe over roll cage, but Senatore's not a man to be argued with. So I grit my teeth and move my foot gingerly from the throttle to the brake and slip it into gear—and voila! The Prowler slides backward down the bank as smoothly as a minivan backing out of my father-in-law's gravel driveway.

"When the angle of the slope exceeds 45 degrees, you can't use traction, you need to use momentum," Senatore lectures. The upshot? Stand on it before the going gets steep.

So I try again. This time I mash the throttle and the Prowler scrambles up the slope happily, catching a bit of celebratory air over the lip, swallowing the landing with its trampoline-like suspension travel, and scooting casually off down the trail.

## THE HUMVEE WANNABES

Welcome to the world of idiotproof ATV riding—and creative automotive design in pursuit of Pentagon contracts. Eager to come up with the next Jeep, Humvee or Stryker, a handful of entrepreneurs are vying to slip past the big defense contractors with nimble, go-anywhere vehicles to serve the needs of the 21st century's nimble, go-anywhere soldiers. Setting aside their military pretensions, some of these creations are darned appealing to any civilian motorhead with an appreciation for low-end torque and mucho styling.

IT PROVED IMPOSSIBLE to find everything we wanted in an off-road fun machine—you know, 72-in. tires, built-in wet bar and plasma TV, plus the amphibious option. So we went ahead and designed our own dream ride. No, it doesn't really exist, but if it did, The Machine would be plusher than Wyclef

## OPTION PACKAGES

### THE EVEREST

- Why drive a monstrous SUV-truck up a snowy mountain? Because it's there. This package's Abrams-spec tracks replace The Machine's wheel sets in the rear, while skis provide flotation up front. A Warn 16.5t winch rated to 16,500 pounds pulls The Machine up the most vertiginous slopes. The sun-filled tent in the rear stows away, leaving a stealth package wrapped in arctic camouflage.



### THE OAKLAND

- City driving presents unique challenges. "Come correct" with panoramic windows coated with BlastGARD glass-retention film. A Case-manufactured forklift up front ensures parking options, while six Klipsch CA-SW-8T all-weather speakers mounted in the vehicle's flanks can produce a concert-worthy 111 dB of sound.



### THE BAJA

- For coastal road trips, the body panels are replaced with an aluminum displacement-type hull by Cool Amphibious. In the water, a separate marine transmission powers twin props, while the rear ramp becomes a swim platform. On shore, the retractable sunscreen/media center makes The Machine the life of the beach party.





# MACHINE

Jean's shark tank-equipped Hummer H2 and tougher than the International CXT megatruck. While the complete vehicle is a product of our fevered imaginations, most of the technology described on these pages is available today.

BY JONATHAN GROMER  
ILLUSTRATIONS BY ZEITGEISSED

## "THE MACHINE" BASE SPECS

- **BODY:** Angular body panels, made of magnesium alloy and carbon-fiber-reinforced plastic panels, reduce The Machine's radar profile; the geometry is based on stealth bomber specs. Evasive capability is augmented by radar-absorbing paint from Plans and Kits Unlimited.
- **ENGINE:** Power derives from a GM hybrid system that pairs an 8.9-liter diesel to two 100-

kilowatt electric engines. The GM system debuted in 2004 on transit buses.

- **TIRES:** Special-order, 72-in. Goodyear Wrangler MT/R tires with Hutchinson run-flat Inserts carry The Machine wherever adventure, or an excellent tailgating opportunity, calls. A Dana Spicer Central Tire Inflation System quickly adapts tire pressure to high-



HEIGHT: 158.4 IN.



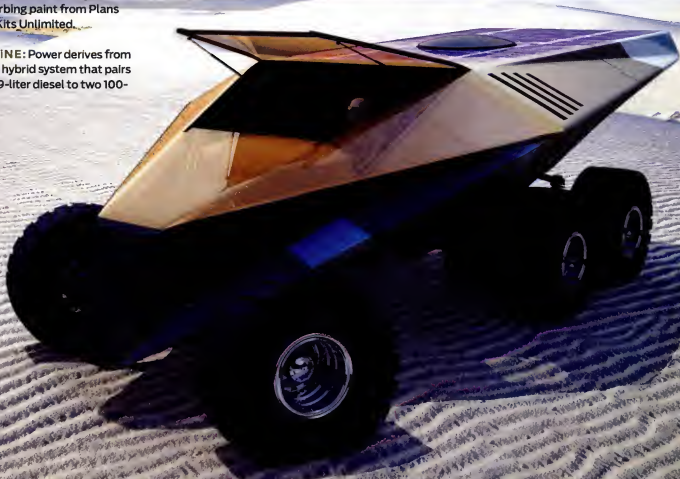
WIDTH: 130 IN.



LENGTH: 360 IN.

way or demanding off-road driving conditions.

- **ON THE ROOF:** Satellite service comes via the Winegard RoadTrip XLP dish; in-roof solar panels, which can open to boost energy collection, provide supplemental power.
- **ENTERTAINMENT:** The Machine's rear compartment unfolds to reveal a glass-screened, 80 x 120-in. Claro Holographic TV and Media System, created by UK manufacturer Wow Factor. It's coupled with a Fujitsu high-def, 68.7 billion-color LPF-D711 projector. A polymerized tatami screen conceals amplified Prothro cloth speakers.
- **TAILGATING:** An Eames-inspired aluminum cocktail bar, manufactured by Mostly Metal, is matched by the Summit Professional Three-Drawer Stainless Steel refrigerator.



The Prowler is a contender on both the weekend warrior and actual warrior fronts. It started life as the brainchild of Amos Deacon, an entrepreneur and ATV enthusiast from California who wanted a safer alternative to four-wheelers. But it soon caught the eye of the guys at Diamondback Tactical, who sell a wide variety of gear to the military, from fatigue-print CamelBaks to body armor. The company hopes the Prowler will fill an important niche on the battlefield. Deployed by helicopter, the vehicles could approach a target from a distance of a few miles for a stealth attack—then get away just as quickly. A number of Prowlers are already in use in Afghanistan and Iraq.

While he waits for a big break with the Department of Defense, Diamondback owner Jason Beck is planning a limited assault on the recreational market. The Prowler is built on a Yamaha Grizzly 660 engine and drivetrain, but it has been tamed with a full roll cage, a lowered center of gravity and a carlike steering wheel in place of handlebars so that balance isn't a factor in steering. The result: a vehicle with formidable off-road capabilities—and a high screw-up threshold.

Beck hopes to sell the single-seat vehicle in kit form in late spring, with a black budget-worthy price tag of around \$20,000. (An '05 Grizzly goes for about \$7000.) The standard 34-hp Prowler that I drove didn't feel the least bit

underpowered—it weighs just 890 pounds—but an option being considered for the kit will be a full-on car engine, and not a wimpy one, either. It will be a tweaked version of a 190-hp Honda VTEC capable of nicely powering a sport sedan. While the standard Prowler has a top end of 68 mph, that model should be able to hit truly scary speeds. More to the point, the souped-up engine will boost torque to over 150 lb.-ft.—useful for cockroach climbs in the backcountry and trash-talking sessions in the parking lot.

## PIMPING YOUR LIGHT-STRIKE RIDE

The wash behind Diamondback's headquarters proves to be a convenient place to test the Prowler's capabilities. Dropping off a lip, heading back down the embankment that I've just worked so hard to climb, the world falls away like the top of a G-Force roller coaster. The Prowler tracks down the steep pitch as if it were on rails, then devours a field of basketball-size boulders like Kirstie Alley eating a Big Mac. Yet as I follow Senator through the parking lot toward the warehouse, the mini-monster's handling is so carlike that I instinctively reach for the turn signal when a Dodge Caravan approaches.

Back in Beck's office—inexplicably outfitted with four flat-panel TVs—Senator and his boss lay out the plans for tomorrow's venture deeper into the desert. But I'm distracted by the piles of Prowler accessories stacked around. If I were buying, rather than borrowing, this would be my chance to pimp my Prowler. Instead of big rims and a

# BEFORE YOU BUY

Jeep, Hummer ... what's next? These kickin' wheels could hit civilian life soon. Order now—supplies are limited.

## RST-V

WHO MAKES IT: General Dynamics  
BEST FEATURE: Diesel/electric engine  
WHO DRIVES IT NOW: The U.S. Marines  
INTENDED USE: Faster, fuel-efficient alternative to that old gas hog, the Humvee  
WHO'D DRIVE A CIVILIAN VERSION: Ralph Nader in '08  
TOP SPEED: 70 mph



## IGUANA FV4

WHO MAKES IT: Sablex International S.A.  
BEST FEATURE: Amphibious option  
WHO DRIVES IT NOW: Most recently, military testers in Brazil  
INTENDED USE: Tough, light, go-anywhere workhorse  
WHO'D DRIVE A CIVILIAN VERSION: Midcareer Dolph Lundgren  
TOP SPEED: 67 mph



## IGUANA

WHO MAKES IT: No relation to the FV4, this hot rod comes from Iguana Technology  
BEST FEATURES: Articulated body  
WHO DRIVES IT NOW: The inventor, who has the only prototypes  
INTENDED USE: Bushwhacking over ditches and rough, swampy terrain  
WHO'D DRIVE A CIVILIAN VERSION: A reunited Creedence Clearwater Revival  
TOP SPEED: 65 mph



## ASV

WHO MAKES IT: Textron Systems  
BEST FEATURES: Handles 5 ft. of water and 2-ft.-high obstacles  
WHO DRIVES IT NOW: U.S. Army MPs  
INTENDED USE: Fill the gap between tanks and smaller thin-skinned vehicles  
WHO'D DRIVE A CIVILIAN VERSION: Noted defensive driver The Rock  
TOP SPEED: 63 mph





thumping stereo, I could add a mount for an M16 automatic rifle, or at least a satellite dish.

Beck breaks into my reverie with an anecdote about a simulated mission one winter. In the driving snow, he drove off the edge of a steep switch-back trail, barrel rolled the Prowler six times and did two endos before coming to rest 100 ft. below. Thanks to the chromemoly rollbar and the five-point safety harness, the now-inverted Beck was none the worse for this thrill ride. "I unbuckled myself," he recalled. "I got out, and we just winched it back up onto the trail and continued on." The moral of the story: "As long as you keep your arms inside, it's just about impossible to hurt yourself."

If this was supposed to inspire confidence, it did not.

"I don't do upside down," Senatore reassured me after Beck was out of earshot. One lesson you learn in combat, he tells me, is that you can't neutralize the enemy when you're dangling from a harness with your butt in the air.

## DRIVING SCHOOL, TAKE TWO

The next morning, Senatore and part-time Diamondback employee Jeff Camblin load three Prowlers onto a trailer and we all head toward the White Tank Mountains, a half-hour outside of town. With towering saguaro cactus, scrub brush and tumbleweed the only vegetation, the White Tanks feel a thousand miles from civilization. That is, until the trail takes a turn, and there's a rusted old refrigerator on one side and a mess of shotgun shells on the other.

"I guess it's Frigidaire season," Senatore deadpans.

As we unload the Prowlers, he points to a steep swath in the foothills. This is our first task of the day. True combat conditions, Senatore explains, consist of driving very slowly over outrageously rugged terrain, often blazing a trail where none existed before. If so, this is a perfect testing ground—sharply angled and littered with jagged granite mini-boulders. Remembering Senatore's admonition from yesterday, I keep my foot to the floor, sticking close to Camblin. As the Prowler bounds over a rock the size of a watermelon, one wheel pops up in the air then drops to the ground. *Voom.*

The wheel gains traction and the Prowler darts sideways off the trail—or what passes for the trail—like a gecko on crack. By the time I get back on the brake, I'm face to face

**AIRBORNE  
DIVERSION:**  
The Prowler,  
which fits in  
a helicopter,  
is a light-  
strike military  
vehicle—and  
a dirt-hungry  
fun hog.



with a 10-ft.-tall jumping cholla cactus, my vehicle tipping downhill like the Leaning Tower of Prowler.

"You okay?" Rocky asks. I give him the thumbs up, with a cockiness I don't feel.

"Put it in Reverse."

Another lesson learned: The "when in doubt, gun it" trick I learned yesterday works only in low-traction situations. On the rocks, where the gnarly tires can get a grip, controlled crawling is the order of the day. Soon afterward, the trail drops off sharply to the left, with a 2-ft. drop-off for the left front wheel. "Just keep coming," Rocky encourages.

*Boing.* The world drops out from under me. I hold on tight as the Prowler teeters to the left ... tipping ... tipping ... tipping ... then suddenly fulcrums back, rights itself and heads down the trail. Wow. If I tried a few of these hairball moves on an ATV, I'd probably be in a medevac chopper by now.

Finally, the day's technical task completed, it's time for a little R & R. We head out of the foothills and into the flat, loose, desert sand, for a full-throttle run, whipping up dust, scaring rattlesnakes, turning off the four-wheel drive and throwing the Prowlers into slides that any drifter would envy.

Then we happen upon a little series of whoop-dee-dooos connected by a couple of banked turns, sculpted by dirt bike riders. In the Prowler, this is better than an amusement park. Catch a little air, bounce around in the belts, and defy gravity in a whole new way. Charge a dollar for this ride, and you'd have a line halfway to Tucson. As I blaze past my partners, my silly smile getting lightly sandblasted, I peek over and notice that stone-cold Senatore is grinning, too. **PM**

# the ultimate

To reach the last great aviation milestone—an unrefueled solo flight around the world—



by David Noland

WINGED WONDER: GlobalFlyer soars above the Tehachapi Mountains of Southern California in preparation for an epic, Earth-circling flight.

PHOTOGRAPH BY MARK GREENBERG/WORLD PICTURE NEWS

Copyright © 2004

# solo

renowned aerospace designer Burt Rutan turned to his best and brightest: the boys of Hangar 63.



Airplane buff heaven lies 75 miles north of Los Angeles, in the high desert beyond the San Gabriel Mountains. The sleepy crossroads town of Mojave, with its vast perimeter of uninhabited scrubland and its 360 days of "severe clear" weather a year, is the perfect place to fly experimental aircraft. Edwards Air Force Base, where the test pilots celebrated in "The Right Stuff" were based, is just down the road.

The Mojave airport, a sort of civilian little brother to Edwards, is home to a staggering variety of exotic aircraft—a remote-control F-4 Phantom taxiing out for a test flight, a bright red MiG-21 stashed behind a hangar, hundreds of mothballed airliners parked beyond the runways—and a number of high-risk aviation enterprises. The best known is Scaled Com-

posites, aerospace designer Burt Rutan's legendary outfit, the birthplace of more cool airplanes than any other place on the planet. The name comes from the company's original focus—long since broadened—on building low-cost, scaled-down flying prototypes for big aerospace companies, and its exclusive use of composite materials to build its aircraft.

Scaled, as the company is commonly called, consists of several anonymous corrugated steel hangar/workshops. On an uncharacteristically rainy morning in October, the open doors on Hangar 63 provide a glimpse of an exotic but graceful triple-bodied, single-seat jet with the wingspan of an airliner. It's the Virgin Atlantic GlobalFlyer, created by a small team of maverick engineers and designers who can't—or don't want to—fit into the rigid bureaucracies of major aerospace companies. Gleaming white, the craft appears to have an almost porcelain fragility.

Sometime in the next three months—precisely when depends on the vagaries of wind and weather—the GlobalFlyer, burdened with five times its empty weight in fuel, will begin a ponderous takeoff roll down the 13,600-ft. runway at Salina, Kan. About 90 seconds later, after lumbering more than 2 miles, the plane will reach a speed of 144 mph, at which point pilot Steve Fossett will pull back on the small, side-mounted control stick.

The GlobalFlyer will lift off, and heading east, begin a long, stately climb. Flying along regular airways, and taking maximum advantage of winter jet stream winds, the Flyer will cross the Atlantic and pass over England, Italy and the Middle East. About 19 hours after takeoff, over Saudi Arabia, the plane will reach its final cruising altitude of 45,000 ft. Then, flying at airspeeds of 250 to 320 mph, it will continue over Southeast Asia, Japan, the northern Pacific and the West Coast of the United States. About 64 hours and 23,000 miles after takeoff, it will land in Kansas, and the last great aviation milestone will enter the record books—a nonstop, solo circumnavigation. “To me, it’s about the most important thing left to do in aviation,” says Fossett, a wealthy 60-year-old Chicago commodities trader who has made a high-profile second career out of notching speed and distance records in balloons, sailplanes and blue-water sailboats. “I’m probably the most successful person ever in long-distance ballooning and in speed sailing. This would be the capstone of my career in airplanes.”

**LINDBERGH. YEAGER. GLENN.** America seems to prefer its aviation heroes solo. After all, Charles Lindbergh wasn't just the first person to fly from New York to Paris nonstop. It was his daring decision to make the flight solo, in a single-engine plane, that made him a legend.

The subject of aviator as lone gun came up on a cool desert evening in 1999 at the Flying M Ranch, a 500,000-acre spread owned by Barron Hilton, complete with private runway. The hotel tycoon and aviation enthusiast had invited a dozen guests—all pilots, like himself—to spend a weekend at his Nevada hunting/fishing/flying retreat. At one point Fossett and Dick Rutan discussed what was the most important aviation record left to break. Rutan noted that the round-the-world, nonstop flight had already been done.

In 1986, Rutan and copilot Jeana Yeager (no relation to Chuck Yeager) had circled the globe in Voyager, a spindly winged, prop-driven craft designed by Rutan's younger brother Burt. For nine days and nights, Rutan and Yeager battled turbulence, storms, fatigue and a malfunctioning fuel system to complete a heroic flight that earned the pilots a medal from President Reagan, and the Voyager a place in the Smithsonian Institution 500 ft. from the Spirit of St. Louis.

“Steve, you could do me one better,” Rutan remembers telling Fossett. “You could do it solo.”

Around the world. Nonstop. Alone. Maybe the greatest solo flight since Lindbergh's. And, Rutan added, he knew just the man to design and build the plane for such an ambitious mission: his brother Burt, who would go on to great acclaim as the winner of the \$10 million Ansari X Prize for the first successful suborbital private spaceship.

Fossett and Burt Rutan soon signed a deal to create



**SOLO SKIPPER:**  
GlobalFlyer pilot  
Steve Fossett's  
60 records  
include the first  
solo balloon flight  
around the world.

“It’s high risk, no question about it,” pilot Steve Fossett says. “We have to do things right.”





Ultrathin paint layer (0.0023 in.) protects structure from heat and UV radiation. Total weight of paint and primer: 23 lb.

The 27-gal. fuselage header tank feeds fuel directly to engine. All other tanks feed into it.

At cruising altitude of 45,000 ft., cabin is pressurized to equivalent of 10,000 ft.

Drag chutes 4 ft. in diameter slow airspeed during final descent. Once deployed, chutes cannot be retracted or released.

Williams FJ44-ATW medium-bypass turbofan has max takeoff thrust of 2300 lb. at sea level. Cruising at 45,000 ft. at Mach 0.47, it generates 450 lb. of thrust.

Fore and aft boom fuel tanks each hold 580 gal. of JP-4, special jet fuel that won't freeze in the minus 100°F temperatures at the cruising altitude of 45,000 ft. To maintain proper center of gravity, an automatic valve alternates fuel feed between front and rear tanks after every 8 gal. consumed.

Main landing gear is retracted with compressed air from a paint-ball gun pressure bottle. Gear lowers for landing by gravity and wind pressure.

Ailerons are split into six segments to avoid jamming at heaviest fuel loads, when wing flexes up to 8 ft. Each aileron weighs only 8 oz.

Unlike most other twin-boom aircraft, the Flyer has two separate tails. Although small to reduce drag and weight, the tails have a long "moment arm"—the distance to the wing. This provides excellent stability, much better than the treacherously unstable Voyager.

## Flying Fuel Tank

Built to fly nonstop around the world (but only once) on about 18,000 pounds of fuel in 13 tanks, GlobalFlyer presented Burt Rutan's team with a huge engineering challenge: how to get maximum distance at minimum weight. Here are some of their innovative solutions designed to enable pilot Steve Fossett to add another aeronautical record to his résumé.

**TEST TEAM:** The crew rolls GlobalFlyer out of Hangar 63 for an early morning test flight at the Mojave, Calif., airport.



the GlobalFlyer. (Airline mogul Sir Richard Branson later joined to help underwrite the venture.) As godfather of the project, Rutan masterminded the ingenious twin-tailed layout of the plane, which became known in-house as Capricorn. But, busy with the nascent *SpaceShipOne* project, he turned the detail design work over to a cadre of his best and brightest, the boys of Hangar 63.

Team leader Jon Karkow, a lean, dark-haired 43-year-old with a quiet and intense manner, was in some ways an unlikely honcho for a cutting-edge enterprise. His own taste in transportation is retro: a 1989 Saab 900 and a 25-year-old road bike with a steel frame. But Karkow's aviation DNA runs deep; as a teenager he mowed lawns to pay for flying lessons and started building his own plane—a Rutan design called the Quickie—in his parents' garage. Armed with an aero engineering degree from Rensselaer Polytechnic Institute, in Troy, N.Y., he signed on with Scaled in 1986. "Over the years, I've done a little bit of everything here," he says. "And for this project I've had to draw on every bit of it."

Joining Karkow in Hangar 63 were Joe Ruddy (structures), Chuck Coleman (fuel and control systems), Bob Morgan (landing gear), Richard Hodgson (shop leader), Shawn Keller (electrical), Clint Nichols (propulsion and flight test) and about 20 others. All had drunk the Kool-Aid of the Scaled design ethos: Make it light and simple, work fast, take risks, and view mistakes as opportunities to improve. Or, as the boys of Hangar 63 put it, "Hurry up and screw it up, so you can fix it."

The GlobalFlyer team's design muse—or, more accurately, its dictator—was Louis-Charles Breguet, the early 20th century French aviator who devised one of aeronautical science's bedrock laws. The Breguet Range Equation decrees that the distance an airplane can fly is determined by three factors: the efficiency of its powerplant, its lift-to-drag ratio, and its fuel fraction (that is, the percentage of its takeoff weight that is fuel). Shooting for a range double that of any aircraft ever flown (except the Voyager), the team made a three-pronged attack on Breguet's law—one that took designers into uncharted aeronautical territory.

Every airplane design starts with the engine, and Karkow initially had his eye on a beauty: the Garrett F109, a tiny turbofan developed for the abortive T-46A Air Force trainer in the mid-'80s. "It was pretty much the perfect engine for the mission," recalls Karkow. "The most efficient small jet ever." But only a handful had been built, and none were available.

The fallback engine was the Williams FJ44, a current-production turbofan for small business jets that Rutan had used in two previous projects. The FJ44 has almost double the thrust of the F109, but it is about 100 pounds heavier and, worse, roughly 20 percent less fuel-efficient. Recalling the frustrating design process, Karkow says, "There were days we didn't think we could do it with the FJ44."

Their attack on the first term of the Breguet Range Equation—powerplant efficiency—had been blunted. Prongs Two and Three would just have to be that much sharper.

**THE SECOND TERM** of the Breguet Range Equation is the fun part: shaping and sizing the wing, tail and fuselage for the highest possible ratio of lift to drag, or L/D. Rutan's preliminary design, with its immense 114-ft. wing-span, promised an excellent L/D. But in airplane design, as



in architecture, God is in the details. While Karkow set to work on the booms and the tail structure, the all-important task of sizing and sculpting the subtle nuances of the wing fell to John Roncz, a brilliant freelance aerodynamicist and software virtuoso based in Elkhart, Ind. Roncz had collaborated off and on with Rutan since 1982 and had designed the wing and propeller profiles for the Voyager.

Scaled sent Roncz the basic layout for the GlobalFlyer in May 2002, along with Mark Mangelsdorf, a former Roncz assistant. The pair hunkered down in Roncz's office surrounded by the battery of seven PCs that Roncz uses to run his complex computational fluid dynamics programs. "Our first performance analysis showed that the plane Scaled handed us wasn't going to do the mission," recalls Roncz. Drawing on his experience with an earlier glider project and a high-altitude drone, Roncz wrote a monster computer program to analyze the constantly changing variables for the global flight, including weight, speed, altitude, thrust, fuel burn—11 factors in all. "It's a gigantic matrix," says Roncz. "You don't know the size until you determine the performance. But you can't know performance until you figure out the size. It's like chasing your tail. In the end, you've just got to make an educated guess and start crunching the numbers."

Bent over their keyboards 12 hours a day, the pair spent

## Route to the Record Book

Here are key way stations in pilot Steve Fossett's bid to be the first to fly around the world—alone, nonstop.



1  
MILE 0  
HOUR 0

Salina,  
Kan.

Takeoff is the most dangerous part of the flight due to the weight of GlobalFlyer with full fuel tanks (22,000 lb.). Ground roll of 11,000 ft. takes 90 seconds. Liftoff speed is 144 mph.

2  
MILE 233  
HOUR 1

Central  
Missouri

Initial climb rate of 500 ft. per minute gradually decays due to engine thrust loss with increasing altitude. For peak efficiency, Fossett must maintain an indicated airspeed of 161 mph.

3  
MILE 1035  
HOUR 3

Toronto,  
Ontario

GlobalFlyer reaches initial maximum ceiling of 39,000 ft. As fuel burns off and the plane becomes lighter, it gradually resumes a very slow climb.



**WORK IN PROGRESS:** GlobalFlyer mastermind Burt Rutan (above, on back) and project leader Jon Karkow fine-tuning their creation. At right, from top: adding hydraulic fluid to the nose gear; Williams FJ44-ATW turbofan; Fosssett will spend three days; team autographs hidden in the plane—a Scaled Composites company tradition.



three months tweaking the wing's size and shape. When the final numbers were in, the resculpted GlobalFlyer hadaced the second term of the Breguet equation: Roncz's calculations predicted it would have a lift-to-drag ratio of 37-to-1—topping even the Voyager's 27-to-1. The numbers promised that, precisely flown, the GlobalFlyer would complete the mission with 3000 miles to spare.

**THE FINAL TERM** of the Breguet Range Equation is the fuel fraction. Airliners typically carry 25 to 45 percent of their takeoff weight as fuel; the Voyager took off on its world flight at 72 percent, by far the highest figure ever. But with its thirstier engine, the GlobalFlyer would have to do even

better—an unprecedented 83 percent. This lofty goal was accomplished primarily by a fanatical attention to cutting weight.

Weight is the enemy of every aircraft designer, but the GlobalFlyer presented an especially nightmarish equation: It requires 5 pounds of fuel to carry every pound of the plane aloft and around the world. Rutan likes to tell his designers and shop people that when they finish building a part, they must throw it up in the air for a weight test. "If it comes down, it's too heavy," he warns, only half joking. The Flyer would have a wingspan greater than a Boeing 737-900's, but the design team set its target empty weight at an absurdly low 3570 pounds—about the same as a Ford Explorer's, and just 4 percent of the 737's.

For the plane's basic structure the team chose a carbon-fiber/epoxy composite with a strength-to-weight ratio seven times better than aluminum. Although carbon composites are cutting-edge in the commercial aircraft industry, Scaled has been building planes with them for 20 years. The GlobalFlyer's main wing spar, which weighs just 580 pounds, consists of 17,575 spaghetti-thin bundles of carbon fiber.

The GlobalFlyer's other big weight-loss secret is its razor-thin structural safety margins. Every part is just strong enough to do the mission. Once. "The basic idea was to see how much we could scare ourselves safely," says structures guy Ruddy. Small private planes are built to withstand ultimate stresses of 5.7 g's. At takeoff weight, the Flyer is rated at only 3 g's ultimate load. That means the wings could break in a severe jolt of turbulence. In the first few hours after takeoff, pilot Fossett will be putting his life on the very thin line between minimum weight and airframe failure.

This structural brinksmanship is carried to its extreme in the Flyer's control surfaces—its ailerons, elevators and rudders. These critical parts are the ultimate weight bugaboo. In order to avoid destructive flutter, the leading edges of con-

*(Please turn to page 114)*

4 MILE 7500 HOUR 19	5 MILE 11,500 HOUR 30	6 MILE 20,075 HOUR 54	7 MILE 20,500 HOUR 56	8 MILE 22,700 HOUR 62	9 MILE 23,000 HOUR 64
<b>Saudi Arabia</b> GlobalFlyer reaches final cruise altitude of 45,000 ft. Cruise speed is 322 mph at a fuel flow of 48 gal. per hour (gph). Aircraft now weighs 15,400 lb.	<b>Southwest China</b> Halfway point. To maintain peak efficiency, speed has been reduced to 291 mph and fuel flow to 37 gph. Weight down to 12,500 lb.	<b>Eastern Pacific</b> Fossett takes a big jog south to meet the 22,858-mile minimum set by the Fédération Aéronautique Internationale, which governs air sports records.	<b>Off West Coast</b> Fossett intends to fly route without sleep, but here would be a good place to nap (with autopilot on) to increase alertness for descent and landing.	<b>Central Colorado</b> Descent for landing begins. Power reduced to flight idle, descent rate 275 ft. per minute. Airspeed 230 mph, weight down to 6500 lb.	<b>Salina, Kan.</b> Landing with twin drag chutes deployed, GlobalFlyer will touch down at a sedate 71 mph, with a rollout of 800 ft.



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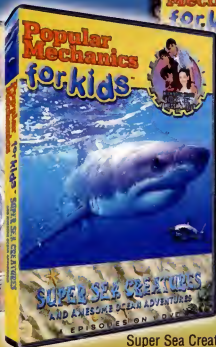
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## Under Pressure

Great clamps for every job.

TEXT AND PHOTOGRAPHS BY THOMAS KLENCK

**Ask anyone who's worked in a wood shop.** When it comes to clamps, you never have enough. The reasons are simple. These are the tools that literally pull your projects together—and the bigger your projects, the more clamps you'll need. They draw all the joints tight and hold them that way while the glue cures. More than that, they're like extra hands that keep work positioned for shaping or

fastening—mechanical hands able to exert pressures that can exceed 1000 pounds and never get tired.

Clamps come in an assortment of styles and sizes to match the wide range of jobs you'll take on. Except for a few special models, you'll find them sold through woodworking supply catalogs, online dealers and many building supplies outlets. Here's a run-down of what you're likely to find.

SLIDING-ARM  
CLAMPWOODEN  
CAM  
CLAMPQUICK-GRIP  
CLAMP

### FAST-ACTING CLAMPS

Fast-acting bar clamps, which feature a sliding arm that contains a screw, are probably the most popular woodworking clamps you'll find. When pressure is applied, the arm locks onto the bar, either by means of multiple clutch plates or by a simple jamming action. Capacities range from 6 to 60 in.—a small light-duty version can cost around \$8 while a large, heavy model will go for over \$30. A close cousin to the fast-acting clamp is the wooden cam clamp (about \$16 to \$22). It has wooden jaws with cork pads and a cam lever that applies a modest amount of pressure. One of the newest clamp designs is the Quick-Grip (right). This trigger-operated tool can be rapidly set and tightened or loosened with one hand. Versions with 6- to 50-in. capacities have reversible jaws so they can act as spreaders (about \$16 to \$37).

BAND CLAMP

FRAME  
CLAMP

CORNER CLAMP

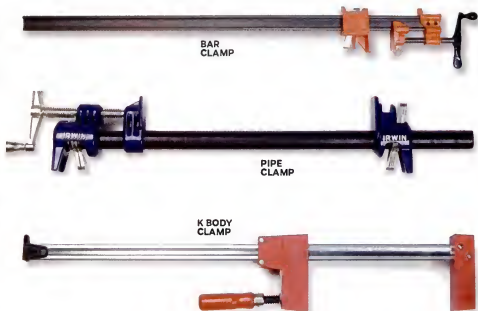


### FRAME CLAMPS

Corner clamps are indispensable for joining wood at right angles. The one shown handles miters and butt joints, and holds the stock while fasteners are applied (about \$22). For assembling all four corners of a frame at once, use a frame clamp (about \$20). It uses threaded rod and corner pads to grip frames up to 24 in. With extension rods it handles 48-in. frames. Another great clamp for frames is a band clamp (about \$20 to \$40). It has a fabric tape that wraps around the work to pull the joints tight. It's great for circular frames and chair repair, too.

## BAR CLAMPS

For assembling wide panels or cabinets, most woodworkers turn to long bar clamps or pipe clamps. Heavy-duty bar clamps have steel or aluminum bars with a threaded head fixed to one end, and a sliding end that locks against the bar when under pressure. The steel I-beam model we show comes in 36-, 48- and 60-in. lengths with prices ranging from about \$30 to \$38. Pipe clamps work much the same way, but utilize black-iron pipe that can be cut to the required length. Our version, made by Irwin, is unique in that the end jaw assembly doesn't require threaded pipe. It's available for 1/2- and 3/4-in. pipe (shown), and costs about \$12. The K Body Clamp made by Bessey offers some real improvements over standard bar and fast-acting clamps. First, it features broad, plastic jaws that provide nonmarring pressure over a wide area. But best of all, the jaws remain parallel so uniform pressure will be applied along the contact area. This clamp comes in capacities ranging from 12 to 98 in. A 41-in. version costs about \$40, and lighter-duty versions are also available.



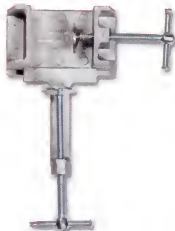
SPRING CLAMP

## SPRING, EDGE AND RIGHT-ANGLE CLAMPS

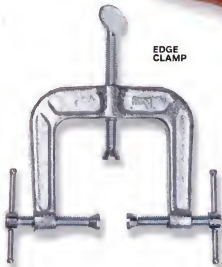
Small assemblies don't require a great deal of clamping force. And in many cases, a simple spring clamp is the most convenient tool for the job. It's best to have a bunch on hand so you can apply uniform pressure to thin pieces, but you won't break the bank—the 3-in. version shown is \$5.50. Smaller sizes are available, as are economical plastic versions. Holding two workpieces at right angles can be done with ordinary clamps, but if the work is large, a dedicated right-angle clamp is handy. This aluminum model costs about \$11 and takes stock up to 1 1/4 in. wide in one jaw and 2 1/4 in. wide in the other. And, for applying edge banding without the hassle of long clamps spanning a wide panel, an edge clamp comes to the rescue. This inexpensive model costs about \$9.



RIGHT-ANGLE CLAMP



EDGE CLAMP





HAND-SCREW CLAMP

### HAND-SCREW CLAMPS

One of the most basic and traditional clamps for woodworking is the hand-screw clamp. It's easy to recognize by its two heavy wooden jaws that provide broad, nonmarring contact surfaces. Passing through the jaws are screws with reverse threads at the ends so the jaws come together rapidly. Hand screws are available with jaw lengths from 4 to 16 in. and range in price from about \$12 to \$40.



RATCHET CLAMP

### PLIER-TYPE CLAMPS

For light-duty gripping and one-hand convenience, a ratchet clamp from Sears fills the bill (about \$20 for a pair). You apply the pressure you need and the jaws stay locked until they're released by a small trigger. For heavier jobs try a locking C-clamp. It works like locking pliers but with greater jaw capacity. This 11-in. model costs about \$18.



LOCKING C-CLAMP



PORTA-VISE

C-CLAMP

### C-CLAMPS

Standard C-clamps may be slow to adjust, but they're still a reliable choice where large jaw capacity isn't required. The 5-in. model shown costs about \$10.50. The ultimate in C-clamp design is the Porta-Vise. It has a non-rotating shaft and pad that enable precise clamping. And the handle can be removed to crank the clamp tight with a wrench. Our 6-in. aluminum version has a clamping force of 2200 pounds and weighs only 3.5 pounds. Quality costs, though, and this model goes for about \$65. Smaller 3-in. and larger 8-in. models are also available.

### FOR MORE INFO

The clamps shown are sold through many mail-order and online retailers and at many hardware stores and building supplies dealers. The following is a list of companies that we used. Jancy Engineering (Porta-Vise), 877-758-4437; [www.porta-vise.com](http://www.porta-vise.com) Constantines Wood Center, 800-443-9667; [www.constantines.com](http://www.constantines.com) Grizzly Industrial, 800-523-4777; [www.grizzly.com](http://www.grizzly.com) Lee Valley Tools, 800-871-8158; [www.leevalley.com](http://www.leevalley.com) Rockler Woodworking and Hardware, 800-279-4441; [www.rockler.com](http://www.rockler.com) Sears, 800-377-7414; [www.sears.com](http://www.sears.com) Wetzler Clamp, 800-451-1852; [www.wetzler.com](http://www.wetzler.com) Woodcraft Supply, 800-535-4482; [www.woodcraft.com](http://www.woodcraft.com) Woodworker's Supply, 800-645-9292; [www.woodworker.com](http://www.woodworker.com)



# Drywall Repair

If only all problems could be patched this easily.

BY MERLE HENKENIUS

ILLUSTRATIONS BY GEORGE RETSECK

**Drywall is relatively simple to install and easy to repair.** It's also easy to repair badly, which can leave a lumpy mess that declares "shoddy" to anyone who enters the room.

It's best to do a repair with three or four thin coats of compound—if possible leaving sanding for just the last coat. Also, "the most important thing with a repair is to build the joint out wider than you would normally," says drywall contractor Rick Schwartz, who serves as secretary treasurer of Marietta Drywall in Marietta, Ga. The key is to leave a wide and very shallow slope on all sides, he says.

A drywall repair toolkit is simple. It consists of flexible knives in 3-, 6- and 8-in. widths, an inside-corner knife, a utility knife, a hammer, a

screwdriver, a drywall saw and a drill. Some repairs also may require a hand sander, a hacksaw, a nail bar and a level. Chances are good that you already own these. As for materials, drywall compound, mesh tape, paper tape, drywall nails and screws take care of most repairs.

Note that in some cases we show mesh tape with lightweight or all-pur-

pose compound applied over it. Strictly speaking, for maximum strength mesh tape is best used with setting-type drywall compound. For small repairs, however, that's impractical. If you're really concerned about strength, use paper tape for all repairs. Be advised that it's more difficult to work with in some of the repairs we show. (See "Compound Interest" below).



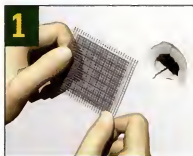
## COMPOUND INTEREST

The two most common drywall compounds are lightweight and all-purpose. They both are easy to work with, and have a shelf life at room temperature of about nine months. If you have an entire house to repair, buy a 4.5-gal. bucket of the material (\$11 to \$15) and keep using it until the project is done. For small repairs, buy a 1-gal. container, but be advised that you might pay nearly as much for that as you will for the 4.5-gal. size, depending on where you shop. For a few minor repairs, buy a quart (about \$5). The differences between the two are that the lightweight product weighs about a third less than all-purpose, it dries more quickly and takes less force to sand.

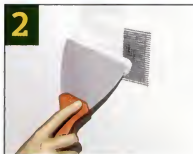
—Roy Berendsohn



## Doorknob Damage



Use a peel-and-stick patch to cover doorknob holes. The patch is an aluminum screen covered by fiberglass mesh. Peel off its backing and press the patch in place.



Use a 4- or 6-in. drywall knife to apply drywall compound over the mesh. Apply three covering coats in all.

## Battered Corners



**1** Begin a repair to a severely damaged outside corner by cutting away the metal corner bead with a hacksaw.



**2** Use a nail bar to pry off the damaged section of corner bead. Hold the new corner bead in place and mark its length.



**3** Cut the new section of corner bead to length and attach it with nails. If the surrounding paint is glossy, sand it before proceeding to the next step.



**4** Finish the repair with several coats of drywall compound. The last coats are applied with an 8-in. taping knife.

## Creeping Cracks



**1** Use an abrasive-coated foam block, known as a sanding sponge, to smooth a working crack. These cracks often occur below a window or above a door.



**2** Apply a thin coat of joint compound to the cracked area. Sand it smooth and apply a second coat if necessary.



**3** Spray elastic crack coating on the repaired area. We used Good-Bye Cracks, produced by Guardsman Products; [www.goof-off.com](http://www.goof-off.com).

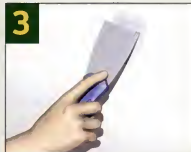
## Nails That Go Pop



**1** Nail and screw pops arise from lumber shrinkage. First, twist a utility knife into the wall to carve away the joint compound from above a popped nail or screw.



**2** Tighten the screw (usually a quarter-turn is sufficient) or tap in the nail. (If the nail seems weak, drive in a second one next to it.)



**3** Use a small drywall knife to apply lightweight joint compound above the screw or nailhead. Three light coats should do.

## Soggy Ceilings



Use a hand sander and coarse sanding mesh to remove texture and smooth out the area when repairing a ceiling.



If water damage has caused a drywall ceiling to sag, reattach it along the seam by pressing up and nailing the drywall to the joist.



Water stains will bleed through a repair. To stop them, apply a coat of stain-sealing, shellac-based primer.

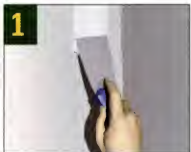


To blend a repair with the surrounding texture, use a roller to apply a mixture of drywall compound thinned with water.

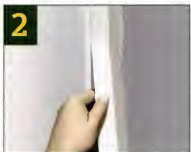


Before the drywall compound dries, add texture to it with a short-handled stomping brush.

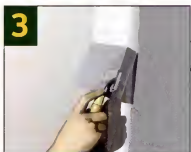
## Inside Corner Cleanup



Cut out a piece of damaged drywall tape in an inside corner, then apply a bed of drywall compound.



Fold a piece of paper drywall tape in half and press it into the wet drywall compound.



Use an inside-corner knife to smooth the drywall compound. Hold the knife at a slight angle to the corner.

## SAFETY FIRST

### Watch The Weight

If you have several large repairs to do and you'll be buying a sheet or two of drywall, be advised that a sheet of regular 1/2-in. drywall weighs about 1.7 pounds per square foot. That means a 1/2-in. 4 x 8-ft. sheet weighs a bit more than 54 pounds (a 3/8-in. sheet weighs almost 45 pounds). If you stand it on edge and it falls over, someone—especially a child—could get hurt.

### Beware Of Buckets

Five-gal. compound buckets pose a drowning or suffocation hazard to small children—when they are new and filled with compound, or later after they are cleaned and used for car washing and other jobs.

### Clean Up The Dust

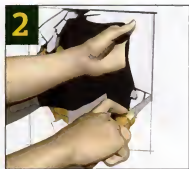
It also bears mentioning that drywall sanding dust is a respiratory irritant. Wear a dust mask when sanding to block airborne gypsum and silica particles. Also, spread a plastic dropcloth nearby. Wipe dust off the dropcloth with a damp sponge, then clean the surrounding areas with a shop vacuum, let the air settle, and finish vacuuming with your household vac.

—R.B.

## Large Hole



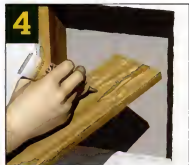
To repair a large hole, first draw a square around it. Use a level to center one side of the square on a nearby stud.



Cut three sides of the square using a drywall saw. Lift off the debris as you cut to keep it from falling into the wall cavity.



Remove the drywall over the stud using a utility knife. Score down the line centered on the stud.



Use a piece of 1x4 pine to provide backing for the repair panel. Apply a generous amount of construction adhesive to the backing board.



Use a pair of C-clamps to fasten the backing board to the surrounding drywall. Some adhesive should squeeze from the joint to indicate a secure bond.



After the adhesive has dried, cut a repair panel to fit, and fasten it to the stud and the backing board with drywall screws.



Apply self-adhering fiberglass mesh tape over the repair-panel seams. Overlap the tape at the corners for maximum strength, and center each piece over a seam.



Use a 3- or a 4-in. drywall knife to apply the first layer of drywall compound over the tape.



Smooth the dried compound with a hand sander fitted with coarse sanding mesh. Level the repair with the surrounding surface.



Apply several skim coats of drywall compound over the repaired area. Use an 8-in. tapping knife, and sand only the last coat.

PM



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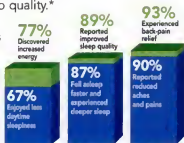
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# Trial By Fire

How to fight a fire, and when not to.

BY ROY BERENDSOHN

**The good news is that the number of** people killed in residential fires is dropping. The bad news is that there are still an astonishing number of people killed or injured in residential fires and the yearly property damage from them is sickening. In 2003, the most recent year tracked by the National Fire Protection Association, there were 388,500 home fires in this country. Those fires killed 3145 people, accounted for 13,650 injuries and did \$5.9 billion in property damage.

And while many people equip their home with smoke detectors and dutifully replace the battery in them annually, they may be poorly equipped to prevent even a small fire from getting out of hand. Your first line of defense is a properly charged fire extinguisher placed where you can get at it as quickly as possible. Don't wait till there's a fire to learn where your extinguisher is or whether it's in working order.

The ABC extinguisher is the most common in residential settings. It uses dry powder and inert gas as a propellant. The familiar red extinguisher has the ABC label positioned prominently on its tank. In most cases, it is a non-rechargeable device with a service life of about 12 years. At the end of that period, you can turn it in at a fire station so it can be used for demonstrations or drop it off at a fire equipment service company. In either case, call first to find out what, if any, requirements exist for dropping off fire extinguishers.

It's good practice to perform regular visual inspections of a residential fire extinguisher. Remove it from its wall

bracket and check that the bracket has not loosened. Have a look at its tank, its pull pin, and check the gauge reading to see whether the extinguisher is losing its charge. Look into the nozzle and hose to be sure that a spider has not built its nest in there. If you're not sure how old the extinguisher is, check the bottom of its tank. You should find its production date.

The extinguisher's A designation means that it's rated to put out fires of ordinary combustibles such as wood and paper. The B designation means that it will extinguish flames stemming from flammable liquids such as grease, oil and gasoline. An extinguisher with a C designation will extinguish an electrical fire.

Bear in mind that the extinguishing agents themselves can do damage. Fire extinguisher manufacturer Kidde ([www.kiddeus.com](http://www.kiddeus.com)) warns that the powder used in B and C extinguishers can fuse to hot oven surfaces, making cleanup difficult. Still, cleanup is obviously of secondary importance to putting out the fire.



## REMEMBER P.A.S.S.

Using an ABC extinguisher is straightforward if you remember the P.A.S.S. sequence:

**P:** Pull the pin.

**A:** Aim the extinguisher at the fire's base.

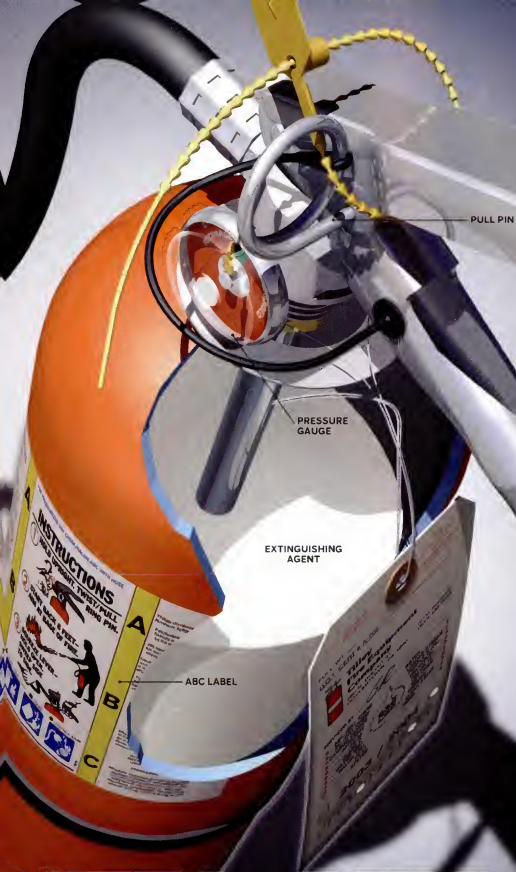
**S:** Squeeze the handle.

**S:** Sweep the extinguisher back and forth.

## WHERE THEY GO

If one fire extinguisher is good, two or more is better and safer. As we show here, it's a good idea to have several fire extinguishers placed around the home.





## FIGHT OR FLIGHT

Fire becomes more dangerous by the second. If you can't fight it immediately, when it's safest, you have a hard choice to make.

Firefighters advise that evacuation comes first if there are others that need care such as the physically impaired or children.

**The time-tested rule holds: Once you've gotten everybody out, don't go back, even if that means consigning your house to the flames.**

Also, evacuate when any of the following occurs:

- A. The extinguisher is out but the fire is not.**  
**B. You sense that it's a lost cause, even if the extinguisher still has extinguishing agent left.**  
**C. The room is filled with smoke.**  
**D. It appears that the fire is going to block your exit at any moment. Remember, you always fight a fire with your back to a clear exit. Never let flames get between you and your way out. If need be, clear the exit path, then get out.** PM



## Homeowners

## Q&amp;A

Professional Engineer Norman Becker solves readers' dilemmas ranging from vapor barriers to pipe noise.

BY NORMAN BECKER, P.E.

## ATTIC VENTILATION AND VAPOR BARRIER

**FIBERGLASS BATT**

**VAPOR BARRIER**

**LOOSE-FILL INSULATION, NO VAPOR BARRIER**

**WITHOUT VAPOR BARRIER, VENT EQUALS 1/150TH OF ATTIC FLOOR AREA.**

**WITH VAPOR BARRIER, VENT AREA IS SMALLER, 1/300TH OF ATTIC FLOOR AREA.**

**BARRIER NEEDED?** Whether a house needs a vapor barrier below its attic insulation depends on how well the attic is ventilated.

## Blown-In Insulation

Is my ceiling missing a vapor barrier? My home is three months old and I noticed the ceiling is insulated with blown-in insulation. When I moved the insulation aside I realized there's no vapor barrier. Should there be one? If yes, what should be done now?

RICH WISNIEWSKI  
State College, PA

A vapor barrier reduces movement of moisture vapor into a space. When combined with ventilation, which helps remove moisture, the barrier keeps moisture levels within a limit that reduces the likelihood of it forming condensation in the attic. Condensation creates an environment conducive to mold and fungi. Mold can be unhealthy to occupants and can ruin stored objects, and fungi can destroy wood framing. Also, condensation may cause paint failures, plywood delamination and corrosion on electrical devices and metal ductwork.

A vapor barrier is not always necessary. Two manufacturers of blown-in insulation (fiberglass and cellulose) said a vapor barrier is unnecessary if the attic is adequately ventilated.

When there is no vapor barrier, an attic is adequately ventilated if there is 1 sq. ft. of net-free vent opening for every 150 sq. ft. of attic surface (lowers reduce the effective opening of vents by about 50 percent). The ventilation should be equally distributed among the eaves or overhang and the ridge, or within 3 ft. of the roof's peak.

## Draining A Lawn's Soggy Spots

In this housing development the property drainage plan was, apparently, to have the houses higher than the spaces in between them, and then to have the lawns slope gently to the street. Water would follow accordingly. Over time, however, low spots have developed about 75 ft. in from the street's curb, and this tends to

(Please turn to page 94)



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impede drainage. Other than filling in the low spots, do you have any drainage suggestions?

JACK LEE  
Bowle, MD

When low spots develop on a lawn over a period of time, I get concerned because they may be caused by decomposing tree trunks and construction debris that has been buried rather than properly disposed of. Although this disposal method is not permitted in most communities, it does occur when builders or subcontractors attempt to save on debris removal costs. In severe cases, a sinkhole develops and the debris has to be excavated before the hole is filled in. If you suspect that debris has been buried, contact your local utility companies to determine where buried utilities are located, and then dig test holes where it is safe to do so. If you encounter buried debris, contact local code enforcement officials.

Assuming the above is not the case, you can install a dry-well drainage system. At each low point bury a plastic dry-well insert, which can be made from a plastic garbage can, with holes cut in the sides and bottom. Fill the can with coarse gravel to prevent it from collapsing. Cover the dry well with a drainage grate to allow the accumulated water to flow into the dry well and to percolate into the ground. If the soil type is such that the water will not readily percolate, you can interconnect dry wells using plastic drainpipes.

The dry well closest to the street should have a drain that terminates at the curb and discharges onto the street. Before installing a dry well, check with your municipal building department. A building permit may be required and you may need permission to cut the curb to install the drainpipe.

## Asphalt On Foundation

**My home's concrete block foundation was covered with stucco and then sealed with asphalt prior to backfilling. What is the**



## SERVICE TIP

### Fill The Trap

Every plumbing fixture must have a drain trap. The trap is a U-shaped device that is filled with water and is connected to the drainage-vent system.

A house's drainage system is filled with sewer gases, and the water-filled trap is important

because it blocks the entry of sewer gas into the home. People who leave their house for extended periods may detect a foul odor in their bathroom when they return. The reason is that the trap has dried and allowed the entry of sewer gas. If a foul odor is detected, open a faucet and let the water run for about 10 seconds. This will re-establish the water seal in the trap. —N.B.

## BOOKSHELF: 500 TIPS AND THEN SOME

We don't mean to brag (well, maybe just a little), but after 20 years and still going strong, our Homeowners Clinic remains a hit with readers. And with good reason. It has covered everything from A (additives for septic systems) to Z (zero pressure in boilers). In analyzing home problems and suggesting solutions, this book serves as a single-volume encyclopedia, a reference that shows no sign of going out of date—much like the Clinic itself.



It keeps chugging along because people will always have questions about their houses' problems. We also know that our trusty columnist, Norman Becker, Professional Engineer, will do his best to provide an answer. The book contains the original illustrations that have rendered the Clinic crystal clear since the beginning. It costs about \$20 at bookstores and through [www.popularmechanics.com/500simple](http://www.popularmechanics.com/500simple).

—Roy Berendsohn

**best way to remove the asphalt from the wall in the areas where it was not covered when backfilled to grade?**

RICHARD D. SMITH  
Keuka Park, NY

According to the Portland Cement Association, stains caused by asphalt are very difficult to remove, especially if the asphalt has been allowed to penetrate the surface.

You can try sandblasting, but I don't recommend it. Because concrete block is somewhat porous, you would have to sandblast quite deeply into it in order to prevent a salt-and-pepper appearance.

In my opinion your best bet is to plant shrubs, which will not only conceal the asphalt coating but will beautify your property.

## Painting A Tub Surround

**I would like to paint my existing tile tub surround. Is it possible? If so, what type of paint would I use?**

KATHY  
Via Internet

There are a number of do-it-yourself paint and epoxy products on the market that can be used to change the

(Please turn to page 97)

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## READER PROJECT



### Helicopter

My kids, Emily and Justin, and I built this model helicopter roughly to one-half scale, based on measurements we took of four working helicopters. Our model, which took us two years off and on to build, is 13 ft. long x 4 ft. wide x 6 ft. tall. The frame

is made of PVC, the tail rotors are ceiling fan blades and the main rotors are baseboard material. The cockpit is made of vinyl and the seats are my kids' old car booster seat frames. The center gauge is a fishfinder monitor, flanked by two gauges from a real helicopter. The rotors are driven by compressed air. One of the tough spots we hit was getting the taper of the tail boom. We made its underside tilt upward by heating the PVC and bending it. Solving problems like that encourages my kids to think and come up with solutions—that's why I love to do these projects.

—Steve Craft, Roanoke, VA

## TOOLBOX

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color of a tile wall. They can be purchased at paint stores, hardware stores and home centers. However, based on my experience of doing home and building inspections for over 30 years, there is no way for a homeowner to use these products to permanently change the color of tiles, especially if the tiles are located in a bath or shower area. Although the paint or epoxy will form a reasonable bond with the glazed surface, after repeated cleaning, which is usually necessary to remove mildew and soap scum, the surface will begin to wear or peel.

## Knocking Water Pipes

Every time I turn the water on, I hear a knocking sound. When I turn the water off quickly, I hear the knocking sound again. It doesn't matter if it's hot or cold water. Can you tell me what is creating this?

DENNIS STEPANOV  
North Potomac, MD

It sounds like you have a water hammer problem coupled with water pipes that are not properly secured to the framing. You may also have high water pressure.

Water hammer occurs when a faucet is turned off quickly rather than when it's turned on. That you hear the noise when you turn the faucet on quickly, indicates that the sudden movement of water causes pipes that are not properly secured to hit against the framing.

Lowering the water pressure, which should generally not be above 60 psi, often can reduce the hammer sound. This is accomplished with a pressure-reducing valve. If that doesn't help, have a plumber install air chambers. These are cushioning devices that absorb the energy caused by water movement.

PM

### Do You Have A Home-Maintenance Or Repair Problem?

Just ask Norman about it. Send your questions to Homeowners Clinic, Popular Mechanics, 810 Seventh Ave., New York, NY 10019 or homeownersclinic@hearth.com. While letters cannot be answered individually, problems of general interest will be discussed in the column.

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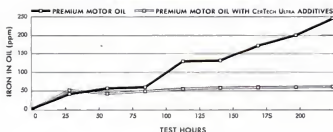
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## CTU TEST RESULTS: IIIF • IIIF (2X) • HFRR

NAME \_ Engine Oxidation Test

DESCRIPTION \_ Measures amount of oil oxidation (which reduces engine life)

RESULTS _ Industry Standard (tested for 100 hours):	275% maximum oxidation allowed
CerTECH ULTRA (tested for 100 hours):	Less than 25% oxidation occurred
Industry Standard (tested for 200 hours):	275% maximum oxidation allowed
CerTECH ULTRA (tested for 200 hours):	Less than 75% oxidation occurred

NAME \_ High Frequency Reciprocating Rig Test

DESCRIPTION \_ Measures friction between metal components (coefficient of friction)

RESULTS _ (As measured between 240 and 260 degrees):	
Motor Sports quality oil alone:	.10
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## SATURDAY MECHANIC

BY MIKE ALLEN

# Changing A Fuse

PHOTOGRAPHS BY DECLAN THOMAS

**It's a dark and stormy night.** Made even darker because the headlights on your car have suddenly quit. The car runs fine—but you have to have it towed to a garage. Tow: \$85. Labor to replace headlight fuse: \$25. One 10-amp blade-style fuse: 65 cents. The realization the next morning that there was a spare fuse already in the fuse box that you could have swapped in yourself for free in a few seconds: Priceless.

### BETTER TO LIGHT A SINGLE CANDLE

Modern cars and trucks are heavily dependent on their electrical systems. The one in your car probably generates more power than was available in your great-grandfather's entire house. You might find three different fuse boxes on your vehicle, and dozens of fuses. Unlike domestic (house) electrical panels,

which rely on reusable, resettable circuit breakers, most automotive circuits use disposable, one-time-only fuses. The only automotive applications that we're aware of that use circuit breakers use self-resetting breakers, which will cycle automatically every few seconds.

## FUSE BASICS

Let's start with the basics. Any electrical component uses a certain amount of power to accomplish its task. Take, for example, a 21-watt brake-light bulb. Two of these add up to 42 watts, which at your car's nominal operating voltage of 14 volts is about 3 amps of current. Suppose the wires to the lamp socket were chafed and the bare wire touched some exposed metal, shorting the circuit to ground. The current draw could instantly rise to dozens of amps—and in a few seconds the



You'll need pliers or some sort of tool to pull the fuse out of its spot.

wiring harness would become a smoking, charred ruin—if it weren't for the fuse. The fuse is designed to carry a precise amount of current and no more. Ask it to do more, and a small wire or strip of metal inside it melts rapidly, sparing the rest of the wiring. And then you can find the short, repair it and replace the fuse for a few cents.

Fuses sometimes fail for what seems to be no good reason. Go figure. One common scenario is when a marker lamp or headlamp burns out. The melting filament in the bulb can momentarily short the contacts inside the bulb just as it vaporizes, sucking enough current to pop the fuse. You'll need to replace the bulb and the fuse.

## GONE FISHING

Not sure which fuse is popped because you don't have a chart? You could always pull all of them, one at a time, and inspect them. A faster way is to use a voltmeter or test light. The conductors inside blade-type fuses are exposed at the upper surface. Start by turning on the ignition and the circuit you're trying to troubleshoot. Connect the ground wire of your meter/test light to a good chassis ground point—one with bare metal. Touch the probe to the fuse's exposed conductor. A good fuse will show voltage on both sides. A blown one will be electrically dead on one side.

## WHAT AMPS?

Fuses are carefully manufactured to permit only a calibrated amount of current to flow. Replace a blown fuse with one with a higher amperage rating at your own risk. You could cause a meltdown in the wiring harness—which will in turn cause more short circuits, some of which may not be protected by other fuses. You may need to replace the entire wiring harness, or you may start an electrical fire that destroys your entire car or truck.

Now that I've got your attention, I'll backtrack and say that in an emergency I once had to replace a blown 15-amp with a 20-amp because that was the only spare in the fuse box. But first thing the next morning I replaced the fuse with the correct one—which promptly blew. The fuel pump was drawing too much current because the fuel filter was dirty, but that's a different Saturday Mechanic.

There are three sizes of blade-style fuses—mini, normal and maxi. And they are all color-coded: normal-size



## Finding The Fuse Box

Which fuse box? Many vehicles have more than one. Generally, the primary box is housed under the dash. Look above the driver's feet (1), behind an access panel at the left side of the dash panel or near the bottom of the glovebox. If it's not obvious, then all you need to do is look in the owner's manual, which will tell you how to find it. The fuse-box cover should have a chart on it (2). There may be a secondary panel underhood, which probably controls electrical circuits for underhood items like the air conditioning or the ABS controller. Again, the owner's manual will tell you where to find this panel.

Aftermarket items (like stereos) sometimes have a fuse in line with their power cord. It may be hidden under the dash and you'll have to run the whole wire with your fingers to find it.

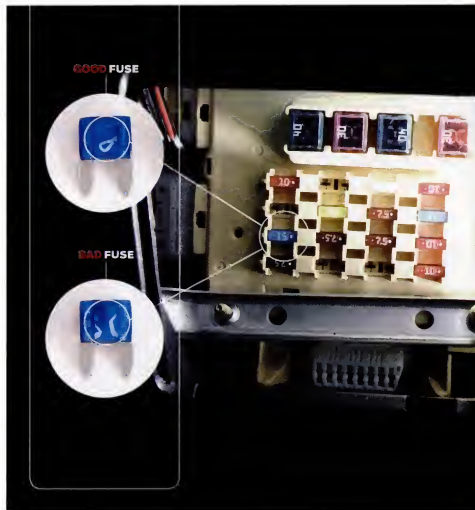


## The Right Fuse

Okay, your headlights are out. Or your dome light, or the power socket won't charge your phone anymore. You've checked the lamp and your phone charger, so you're pretty sure the fuse is blown. But which fuse? There are a couple of dozen, of all different colors. The fuse box cover panel almost always has an index printed on its interior as to which fuse controls which circuit. If not, the owner's manual has an index.

Removing the suspect fuse is simple—yank it out. If you have a car made in the late '80s or afterward, it probably uses blade-type fuses, which can be simply pulled straight out of their sockets. Of course, it's not likely that you can get them out with your bare fingers. You'll need to use a tool of some sort. Some thoughtful car manufacturers provide a fuse puller, neatly installed in the fuse box. It's simply a small pair of tweezers with jaws perfect for yanking fuses. Grab, squeeze and yank.

If your vehicle uses old-style glass fuses, you may need to pry them out of their clamp. Warning: Glass fuses will break if you pry on them hard enough. Instead of levering on the glass, pry from one end of the fuse. If you must pry from the side (because the fuse box is in an inaccessible area), pry the metal cap. And remember that you need to replace that fuse, so don't muck up the fuseholder blades—they need to make good, tight electrical contact. No fuse puller? A small pair of pliers will work. Also, you can try prying the fuse from the panel with a screwdriver—there's a small lip on the top of the fuse body to grab. Just be careful where you stick the screwdriver so you don't short something else out. To



replace the fuse, just push it in with your finger.

Older, European-style fuses use a simple piece of sheetmetal wrapped around a ceramic fuse body. They're pretty stout, but they're prone to corrosion between the end of the fuse and the contact; try spinning the fuse in place to re-establish contact if you've got a problem and the fuse looks good. This style of fuse isn't color-coded—read the fine print for the rating.

10-amp fuses are red and 15-amp fuses are blue, and so on. Just to confuse the issue, the color-coding is different for the maxi sizes. Don't make a mistake and assume a red fuse is always 10 amps. Additional warning: Don't assume the last person to replace a fuse did so with one of the correct rating, even if he was a professional. As always, you can look in the owner's manual—and probably on the fuse chart on the fuse box cover—for the correct rating.



This glass fuse fuse-box housing melted after a loose clamp overheated.

## NO SPARES?

Some vehicle manufacturers do not provide spare fuses or even a place in the fuse panel to store them. Even if there are spares in your fuse box, there are probably only a couple, and not one of every value. Go to the auto parts department or auto parts store and buy a fuse kit. For less than 10 bucks you can get a box containing an assortment of fuses with a fuse puller inside. Leave this in your glovebox to keep it dry and clean.

PM



## AUTO CLINIC

BY MIKE ALLEN

# Taking Up Residence

**Q** My pickup came new with those expensive spark plugs that never need changing. Of course, I needed to change them after the engine started to misfire at about 120,000 miles.

Two of them turned out of the head just fine, and looked fine. I needed to use an air tool to move two others, and they looked fine as well. Another came out with the air wrench—and it took most of the threads in the cylinder head with it. I'm afraid to turn the others. My mechanic refuses to attempt to try and remove them, and I can't say I blame him. He wants a great deal of money to replace the cylinder head with the stripped threads. Someone told me about a gadget to fix the threads, but I can tell from the amount of aluminum in the spark plug's threads that it won't hold. My mechanic says the only fix is to pull the head. Suggestions?

GARY TESTATE  
Trenton, NJ

**A** As I predicted when those 100,000-mile plugs hit the market, they get mighty attached to the cylinder head after a number of years and countless hot-cold cycles.

(Note that those plugs are generally rated for somewhat less than your 120K mileage, but too late now.) The newer plugs have a plating on the threads to prevent this sort of thing,

but experience in the field has shown it's not effective forever. And I'm old school—I like to look. So I pull the plugs every couple of years. I also carefully add a small amount of antiseize compound to the threads. Care is needed to keep the conductive antiseize away from the electrode, insulator and wiring.

Never use an air wrench on spark plugs. Conventional wisdom says to remove plugs from a cold engine, probably because mechanics like to tell customers they need a little time, but it's really about not burning their hands. I don't like to burn my hands

Plugs that haven't been removed in a long time + aluminum heads = stripped threads.

(Please turn to page 104)

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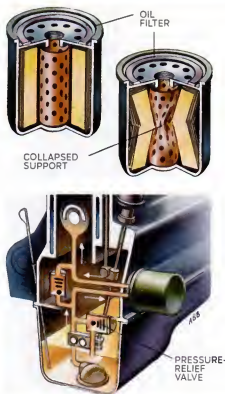
either, but if a plug is stuck good, I'll try again on a hot engine—it makes the plug easier to break loose.

Now, about your stripped plug hole. Your mechanic has no good reason to repair your ham-fistedness for cheap, and I don't blame him either. A good mechanic or machinist can drill or ream your spark plug hole for a Heli-Coil or a threaded insert. I do this all the time, but I don't recommend trying it yourself on an expensive cylinder head. It probably can be done without removing the head from the engine.

## Flushed

**Q** I took my two GM cars to have the antifreeze flushed. Since then, two different dealers have told me that I have the wrong antifreeze, and that I need to have the green kind removed and the GM-spec brown stuff put back in. The shop that did the flushing

## CAR CARE TIP STUCK PRESSURE-RELIEF VALVE



The oil pressure gauge was pegged hard up against the pin. Too much oil pressure, even for fast idling on a cold winter morning. I shut down the engine, counted to 10, and restarted. Oil pressure dropped to normal, and then plummeted low enough to make the oil light flicker. Revving the engine made little change. I pulled into the shop and removed the oil filter. Its steel internal support core had been crushed by the combination of high pressure, high flow and cold, thick oil. The proximal cause? A sticking internal pressure-relief valve that forced all the oil through the filter instead of allowing the oil to bypass it. The ultimate fix was to rebuild the pressure-relief valve. Most modern cars have a bypass in the filter canister to prevent this.

ILLUSTRATION BY ADOLPH E. BROTMAN

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and refilling says BS. They say that GM's brown stuff will eat the radiator and heater core.

#### CONFUSED IN MINNESOTA

**A** GM coolant is orange, not brown, and it's supposed to be good for as long as 100,000 miles or 10 years, in GM cars engineered to use it. Leave your green coolant in for two years, then decide if you want to go back. Either works when you follow the manufacturer's recommendations. All cars will have issues with corrosion if either the orange or green coolant is left in too long or there is some problem with the cooling system.

#### Tired

**Q** The local tire dealer just refused to put two snow tires on the front of my Mercury Sable wagon. He said I had to have four snow tires to prevent the back end from break-

ing loose and going into a spin. I think that with good all-season rubber on the back and ABS, this situation is unlikely, and he's using scare tactics.

GERRY CAVALLO  
Littleton, MA

**A** I'm voting with the dealer on this one. You stand the chance of massive oversteer on snow, and massive understeer on dry or rainy surfaces. ABS comes into the equation only when the brakes are applied, and it isn't designed for this type of situation.

My advice? Get four cheap steel rims at a salvage lot, and swap them back and forth twice a year yourself to pay for two more snows.

PM

#### DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Send your questions to Auto Clinic, Popular Mechanics, 810 Seventh Ave., New York, NY 10019. While letters, faxes, phone calls or e-mail cannot be answered individually, problems of general interest will be discussed in the column.

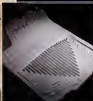
#### SERVICE TIPS

- Does the ABS in your late-model GM truck activate randomly at low speeds, like below 5 mph? Technical Service Bulletin (TSB) 03-05-007A says it's because dirt may have built up on the mounting of the ABS wheel-speed sensors on the front wheels, making the air gap to the hub reluctor ring too large. Remove the sensors, and clean, check and reinstall them.
- Does your 1999-2005 GM truck with the 6.0-liter gas engine make a popping/snapping noise as it's idling or right after it's shut off? Does this noise bother your neighbors or wife? You can show them TSB 03-06-05-008A, which starts out by explaining that these noises are normal. It then continues for several pages, explaining how to replace exhaust components to improve the situation. Don't show them that part.

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# Straight To DVD

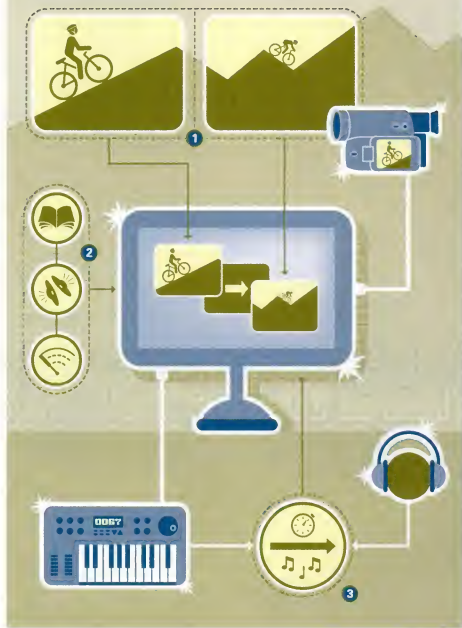
So you want to be in pictures? New software makes it easy to edit your own home-movie blockbuster and put it on a disc.

BY ED FINN

**Now that all your friends are tired** of hearing about the great vacation you just took, it's time to put the highlights on a DVD and make them watch it too. Considering how many people have digital movie cameras today, it's amazing how few follow through and edit their home movies into a watchable form. But it is surprisingly easy. And, with DVD burners standard on many home PCs, so is the final step: burning your masterpiece onto a disc that you can hand out to family and friends.

Let's start with the software. At the low end of the spectrum, Cyberlink's Power Director 3 (\$70) and Ulead's Video Studio (\$100) make it extremely simple by guiding users through the moviemaking process, but neither gives you a huge amount of flexibility. At the higher end of the spectrum are products such as Adobe Premiere Pro, which can cost you upward of \$700. These can yield an almost professional final product—but be ready to spend as much time reading the manual as you do creating your movie.

The benchmark for amateur-level DVD editing software may be Pinnacle's Studio Plus version 9, which costs \$100. Earlier versions of the software proved easy to master, yet powerful. The addition of new features such as still-image pan and zoom makes the package even more useful, without complicating things too much. For this article, we used Studio Plus to illustrate the DVD-



authoring process, from importing clips to munching popcorn.

**1 Getting the clips together**  
Adding clips into your timeline First, import your clips into your computer. Connect your camcorder to your computer with FireWire (IEEE 1394) or USB. The software lets you choose at what resolution you want to capture the clips—if you're making high-quality DVDs, be prepared to

use up about 1GB of your hard drive for every 4 minutes of footage. One key: Turn off any other applications you have running, since video editors don't play well with other programs. You'll need all the processing power you can muster to capture video at a high frame rate.

Next, divide your video into scenes. If these scenes (called "vids") look bad, now is the time to do a little touching up. Studio Plus lets you fix  
*(Please turn to page 108)*

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## Making A Movie With Pinnacle Studio Plus v.9

**SETTING THE MODE**  
Creating a movie on Pinnacle Studio Plus v.9 requires three modes: Capture, Edit and Make Movie. Set the mode by clicking on one of these three tabs and you'll be able to select which step of the movie-making process you want to work on.

**TIMELINE**  
The timeline is where you arrange your video clips and where you'll eventually drag and drop all of your audio, graphics and effects to make an edited movie. It also shows the positions of your clips and how long each one is. Think of the timeline as the skeleton of your film.

**ALBUM**  
Everything you need to make your movie is stored in various sections of the album. Your captured video and sound files are represented here as thumbnail icons. By clicking the tabs running down the left side of the album, you'll be able to add effects.

**PLAYER**  
Here's where it all pays off. The player is where your movie can be previewed. It also can preview any thumbnail from the album. The playback controls (which work just like a DVD player's) let you play the whole video or clip—or go to an exact position within it.

brightness and contrast right at the beginning. Most editing suites also let you add still images, so if your friend shot incriminating photos at the bachelor party while you were off interviewing the best man, now's the time to add them in.

**2 Organizing and connecting the clips** Using transitions, fades, wipes and other effects Adding text, images or sound effects Once you've got your clips on the computer, you have to put them together. Studio Plus lets

you arrange your scenes on a timeline that runs along the bottom of the window with icons representing sounds, effects, graphics and transitions. Audio appears beneath each scene—the editing software assumes you want to keep the sound you recorded with your video—but if you want to do a voice-over, add music or remove the original audio entirely, you can add and remove this material from the timeline just as you can the video.

Studio Plus makes it extremely easy to drop in special effects (like wipes or fades), but you have to be

careful with this power. When deciding how long to keep these effects on screen, make sure your timing is right. A car driving into the distance might look graceful with a slow fade—your sock drawer, not so much. Unless your target audience is 10 or younger, resist the fancier transitions. Less is more.

**3 Syncing the film to music** Selecting tracks In Pinnacle Studio Plus, you can have up to three sources of audio going at once: the video's original soundtrack and [\(Please turn to page 110\)](#)



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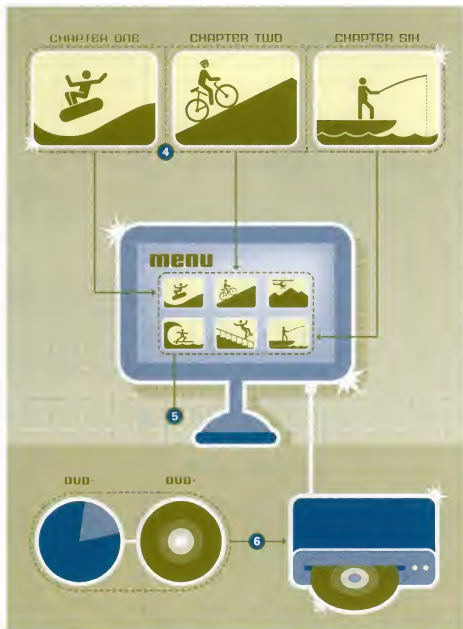
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two others—music, voice-overs, sound effects, karaoke, whatever. Keep in mind that the audio you choose can eat up hard drive space, especially if you record a lot of voice-overs (since they're not compressed, they take up more space than MP3s). Studio Plus even lets you prep the clips for surround-sound systems. Just click on a button and you can hear the motocross engine you recorded travel from left to right in time with the video.

**4 Putting It all together on the timeline** Getting the final cut ready for a DVD Lining up the elements on the timeline is simple as pie—each clip or scene takes

up only as much space as it is long. Cut elements that are too long. And for your kung fu masterpieces, Studio Plus even lets you speed up or slow down scenes.

**5 Creating menus Still-picture menus Making chapters** Creating thumbnails Menus allowing viewers to select and watch scenes will be the first element seen when you show your DVD, and there are nearly as many menu options as there are transitions. You can use premade layouts (which are pretty cheesy), create your own or import graphics from some other program. Our advice: Take all

your creative energy away from silly transitions and devote it to really amazing menus instead.

Then you're ready for making chapters, like the ones on a movie DVD that let you pick which scene you want to watch. The software automatically generates chapter buttons with attached screen shots, dividing your film into manageable segments. It can also automatically generate thumbnails or mini clips from each chapter, making your production menu snazzier and less generic.

**6 Burning the disc Picking the right recordable DVD** Using your space wisely Before you can actually burn the movie to DVD, your editing software has to render it. This means implementing all the transitions, special effects, and other bells and whistles, and generating all the individual frames that will make up the final product. Like capturing the video, this is brain-intensive for your computer, so be sure to close any programs you don't need. Once the rendering's done, you're ready to burn your work to a blank DVD. What kind of DVD? Double-check to make sure the DVD format you're going to use works on whatever players you've got. Depending on how you choose to balance image quality and time, a standard 4.7GB DVD will hold between 1 and 2 (or more) hours of footage.

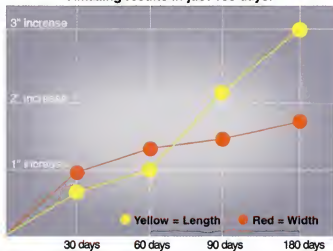
**7 That's a wrap** Now that you've made your first home movie, you may feel like it's time to throw it away and start your second, infinitely cooler opus. Just remember that as computers get more sophisticated, you'll be able to use more of the tricks Hollywood pros include in their DVD presentations. And now that you know what the software can do, you might start shooting footage with transitions and menus in mind. Studio Plus even includes an "auto-moviemaking" function that claims to edit the movie for you. Maybe next time, guys. For now, that's a wrap.

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## TECH CLINIC

BY JOEL JOHNSON

### Earbud Dilemma

**Q** I recently dropped \$50 on the Sony MDR-EX71SL earbuds—the ones that go inside your ear canal, instead of just resting in front of it. Because I have a really small ear, I had to use the smallest of the three earbuds that came with the headphones so they fit snugly. The problem is, I lost one of the replaceable silicon bits off the end of one of the earbuds. I looked through the Sony Web site and Amazon, but they don't sell just that little silicon piece for that particular earbud. Where can I find one?

**A** I have those headphones myself and they really are great. They make subway and airplane rides a lot more enjoyable—it's nice to be able to turn up your music to a reasonable, head-splitting volume without bugging your fellow travelers. But since those silicon tips are pretty much half of what makes up the entire earpiece, you'd think Sony would make it a little easier to order replacement parts. They don't come off very easily (otherwise they'd get lodged in your ear), but it's easier and slightly less disgusting to remove them when you're cleaning them off, which, sadly, slightly weakens the part where they grip.

Now if you go to the Sony Web site, they'll be happy to sell you the headphones themselves, or even offer to sell you a handy MP3 player to go along with them, but replacement bits are nowhere to be found. (Sony is finally selling the white version of these headphones in the United States, so if you hadn't already bought them you could easily get

them in iPod-matching white.) Fortunately, online electronics importer Audiocubes.com—which coincidentally used to be one of the only places you could get the white version of the headphones—sells sets of replacement tips for just \$10. Just do a search on the Audio Cubes Web site for "Sony replacement earbuds."

### Moving Pictures

**Q** I shoot a lot of outdoor photos, often from a kayak. Whenever possible, I use a monopod propped on the floor of the kayak, but it's difficult to maneuver the craft when holding a camera and pod with one hand, leaving me only one hand to paddle.

I'm wondering if there is a harness-type support available that I might be able to strap to my torso to stabilize the camera. I'm also hoping it would hold the camera close to the shooting position so I can move quickly, without tipping over. Do you know of such a gizmo?

**A** While I know of a couple of different harnesses designed to strap motion-picture cameras to a person—usually to get a dramatic, up-close shot that couldn't be done with a traditional camera—such systems, like the Bodymount from Doggicam, could also be used with a still camera ... for a rental fee of \$350. Per day. You would think there would be a better solution, but even professional outdoor photographers say that the best way to go is to custom build your own system.

One DIY route, recommended by Mark Gamba, a National Geographic photographer, is to leash the camera



### Sound Check

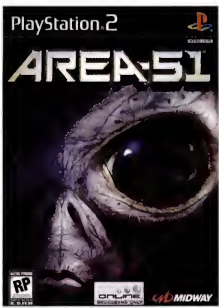
**WANT SURROUND SOUND** without the multiple speakers? Keep your TV room clutter-free with the new **ZVOX 315** virtual surround sound system (\$200, [www.zvoxaudio.com](http://www.zvoxaudio.com)). A perfect complement to a flat-panel TV, it's only 17 in. wide and consists of just one little silver or charcoal box. Three speakers, a subwoofer and an amplifier are all smashed into the 315, providing a big, balanced sound. The one-cable setup is gloriously easy, and it's not just for TVs. Hook it up to a DVD player, CD player, iPod or any other audio source (even your gaming console).



## Gaming The System

**IF YOU LOOK**  
forward to  
watching

late-night reruns of "The X-Files," Midway Games has the perfect fix for your alien addiction. **Area-51** (\$50, [www.midwaygames.com](http://www.midwaygames.com)), an update of an '80s arcade shooter game, has hit shelves for both Xbox and PS2, featuring David Duchovny as the voice of main character Ethan Cole. Sent to check out a viral outbreak in a quarantined military facility, Cole finds a bunch of nasty mutants and aliens—here to do us all no good. Shoot them with a variety of tools including submachine guns, and even blast away with alien weapons. And don't forget all the mutant powers you will possess once you enter the covert area.



to your vest. Using a waterproof camera housing from AquaTech (\$500 to \$3500, [www.aquatech.com.au](http://www.aquatech.com.au)) and some dry rope and carabiners from an outdoor store ([www.rei.com](http://www.rei.com)), you can secure the camera to your life vest so it doesn't float downriver without you. Add a Velocity 7 Photo Sling Pack from Tamrac (\$70, [www.tamrac.com](http://www.tamrac.com)), and you can keep the camera close to your chest for easy access. You'll still have to point and shoot and paddle, though, so choose your photo ops carefully.

Finally, if you really want a ready-made product, you could try a clamp-mount tripod. Pedco ([www.pedcopods.com](http://www.pedcopods.com)) has a wide variety of cheap models including the UltraClamp, a \$30 unit with a screw-clamp bottom. It won't put the camera right up to your eye, but it'll keep everything secure (and out of the water) while you paddle.

## Router Reasoning

**Q** I bring home a work laptop sometimes, just because it's easier than trying to e-mail myself all my files. However, to connect it to the Internet, I have to unplug the DSL cable from my PC, then plug it back in when I'm done. I know there are better options out there, but every time I go to buy some-

thing that will help, I get confused about what I need. Nothing fancy, just something that lets me plug in more than one computer at a time.

**A** What you need is a router, plain and simple. A few years ago routers were high-end hardware, but now you can pick one up at almost any major retailer for less than \$50. There's a huge range of features, but if you want to guarantee success in your situation, just pick up anything labeled "broadband router."

That being said, I bet that work laptop of yours has a Wi-Fi card built in. That means you could spend just a little bit more money—we're talking maybe \$5 or \$10—and buy a router that will let you connect to the Internet wirelessly. Just be sure to change the default password on the router (the instructions will tell you how). It takes only about 10 minutes, and it can be the difference between having some security and having none at all.

But I bet you wanted me to tell you exactly what to buy, huh? My vote is for the Linksys WRT54GS. You can find one for around \$75 ([www.linksys.com](http://www.linksys.com)). It's easy to set up, supports the faster 802.11g Wi-Fi standard, and can be tweaked to add all sorts of extra functions. **PM**



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## THE ULTIMATE SOLO

(Continued from page 79)

trol surfaces must be counterbalanced with lead. The elevators, for example, require 1.7 pounds of lead to counterbalance each pound of structure. Factor in the Flyer's 6-to-1 fuel penalty, and every pound saved on an elevator results in a 16-pound reduction in takeoff weight.

Ruddy attacked with a weight-slashing vengeance. For the ailerons, he used only two plies of carbon fiber instead of the usual four. He eliminated the normal supporting ribs in favor of tiny foam stiffeners. The bottom surfaces, protected from the sun, were left naked to save the weight of the paint.

The results were breathtaking. Each of the GlobalFlyer's 3-ft.-long ailerons weighs a scant 8 ounces. "We had to be careful with them around the shop," Coleman recalls. "A breeze could blow them out of your hand."

At Scaled, the first weighing of a new airplane is a big event. Word gets around. People drop by. Money is wagered. Typically, Scaled air-

craft weigh in at 7 percent over design weight, a low figure for the industry. Karkow, however, was so worried about GlobalFlyer that he kept the initial weigh-in a secret. Just to be sure, he scheduled it late at night, after all potential prying eyes had left. "I was extremely nervous," he recalls. "Were we too heavy? Was the center of gravity off? There was so much suspense."

As the team ratcheted the plane up on three weight-sensitive jacks, the digital readout scrolled up like a pinball machine. When all four wheels had cleared the hangar floor, the readout blinked and stopped at 3320—250 pounds below the design weight. "We couldn't believe it," recalls Karkow, smiling at the memory. "We looked at each other and said, 'This can't be true. We must have left something off.' But they hadn't. They'd aced the third variable of the Breguet Range Equation."

Karkow, a laconic fellow with a dry sense of humor, immediately sent off

an e-mail to Rutan. "We blew the empty weight estimate by over 200 pounds," he reported somberly. The next day, Rutan congratulated the team for being only about 7 percent overweight. Only then did the boss learn that his team had beaten the estimate by 7 percent.

### BY LATE NOVEMBER 2004

the Flyer had made 21 flights up to 45,000 ft. at speeds of about 350 mph. The heaviest weight flown was 19,000 pounds—86 percent full fuel. Roncz's cruise-performance predictions were spot on, and the team is confident that, properly flown, the Flyer will make it around the world with fuel to spare. "It's a real good airplane," Rutan says simply.

Karkow, also the Flyer's test pilot, reports that the plane behaves well. "The long wings make it sluggish in the roll axis, but overall it flies like an airplane," he says. This is good news for Fossett; although an accomplished



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pilot with 2800 hours of jet time, he is by no means an experimental test pilot. By Thanksgiving, Fossett had made four flights at weights of up to 10,000 pounds. "It's surprising how well it flies," he reports. "Jon Karkow has done a remarkably good job."

But there are really two different airplanes: Flyer Lite and Flyer Heavy. Lite may fly surprisingly well, but as fuel is added and weight climbs toward the full-tanks maximum of 22,000 pounds, strange things begin to happen. Climb rate decays. The wingtips bow more than 8 ft., and handling becomes even more sluggish. How will Flyer Heavy behave on its first (and only) flight at maximum weight? Fossett will find out a few seconds after takeoff. "It's high-risk," he agrees, "no question about it. It just means we have to do things right."

Once safely aloft on the three-day world flight, GlobalFlyer will hum serenely along on autopilot. Fossett will remain semireclined in the phone

booth-size cabin, which will be pressurized to an altitude equivalent of 10,000 ft. With parachute stowed nearby, Fossett will be able to peer out through two small side windows. (He'll sit up and peek forward through the tiny canopy above his head only for takeoff and landing.) He'll pass the hours adjusting engine power, monitoring the autopilot and talking to ground controllers. He'll snack on diet milkshakes, and pee into a relief tube. Sleep? "Somewhere between very little and not at all," Fossett says.

The Flyer will cruise well above most of the bad weather and turbulence that battered Voyager. That plane's fuel system was a nightmare: When both engines quit at night over the Pacific, Dick Rutan and Yeager had to improvise an emergency replacement of a fuel pump. GlobalFlyer's fuel management, however, is almost entirely automatic. Says Coleman, "If we've done our jobs, and everything goes well, Steve is basically just going

to have to sit there for three days."

But that in itself is no small feat. Brute-force endurance under stress plainly suits Fossett, who's put in thousands of hours alone in cramped balloon gondolas and heaving sailboat cockpits. "I'll never play center field for the Yankees," Fossett says, "but for endurance feats, there's always a way to figure it out." Even his physical exploits—swimming the English Channel, mashing the Iditarod, running the Ironman—have the common thread of maniacal doggedness. By comparison, sitting in GlobalFlyer for three days should be nothing more than an enforced vacation.

If Fossett succeeds in his round-the-world quest, neither he nor Rutan is likely to shrink from the spotlight. But the unsung heroes will be the boys of Hangar 63. With imagination, savvy and hard work, they will have made a risky, groundbreaking adventure look almost easy.

PM

Additional reporting by Jim Sugar.

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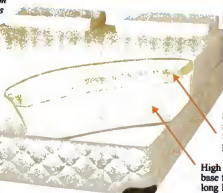
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No grain, no glory: This imported specialty malt is used in Avery's White Rascal, a Belgian-style ale.

## AGING BARREL

Avery ages select beers (such as his Beast line) in 59-gal. oaken casks like this one, formerly a port wine barrel. "There are only a handful of American microbrewers aging beers this way," he says with pride.

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